Malvern | Material relationships

ZETASIZER **NANO** Series

PERFORMANCE, SIMPLICITY, VERSATILITY

- PARTICLE SIZE
- MOLECULAR SIZE
- MOLECULAR WEIGHT
- ZETA POTENTIAL - PROTEIN CHARGE
- RHEOLOGICAL PROPERTIES

ZETASIZER **NANO** SERIES

Research Performance, Operational Simplicity, Application Versatility

The Zetasizer Nano series has been designed with you and your requirements in mind. You need a reliable system that gives consistently good performance, that is easy to use, and covers your range of applications.

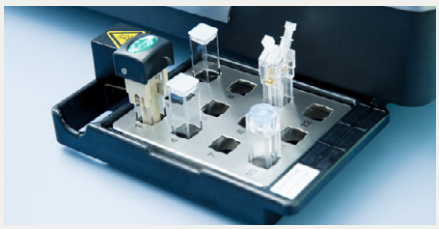
For colloid, nanoparticle and macromolecule characterization, our customers tell us that the Zetasizer Nano instruments are the most user-friendly systems available. As well as this ease of use, the performance and confidence in the results is validated by the fact that 94 of the World's top 100 universities have invested in a Malvern Zetasizer Nano*.

From the top of the range Zetasizer systems incorporating Non-Invasive Backscatter (NIBS) optics, to the affordable 90 degree scattering systems, there is a Zetasizer suitable for every laboratory involved in the characterization of nanoparticles, colloidal dispersions, polymer and protein solutions.

*Top 100 Universities: QS World University Rankings 2011

Key benefits of the Nano Series

- Choice of technologies in a compact unit gives exceptional versatility
- Simplicity of operation means minimal training and robust results
- High sensitivity for nanoparticles, proteins and macromolecules
- Disposable zeta potential cuvette for fast, accurate and easy measurements
- High optical quality and temperature control ensures accuracy and repeatability
- Novel microrheology option to determine viscoelastic properties
- MPT-2 Autotitrator option for automated trend measurements.

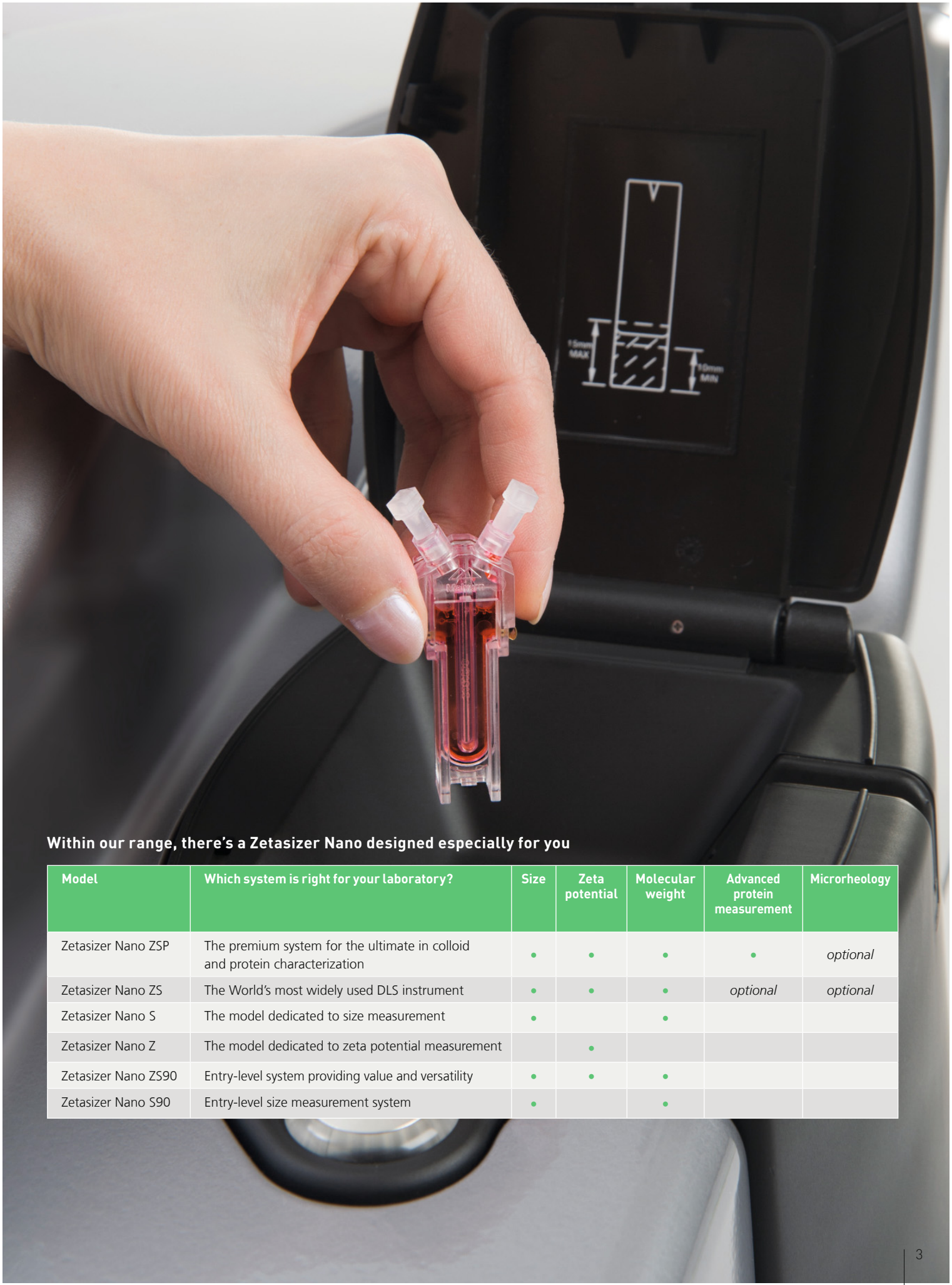


There's a Zetasizer Nano for every application

- Shorten development time for colloid and emulsion formulations
- Improve formulation stability
- Assess protein formulation stability
- Explore protein aggregation and oligomerization state.

Technologies incorporated

- Dual angle Dynamic Light Scattering (DLS)
- Non-Invasive Back-Scatter (NIBS)
- Static Light Scattering (SLS)
- Electrophoretic Light Scattering (ELS)
- Mixed mode measurement, phase analysis light scattering (M3-PALS)
- Microrheology
- Protein measurement software.



Within our range, there's a Zetasizer Nano designed especially for you

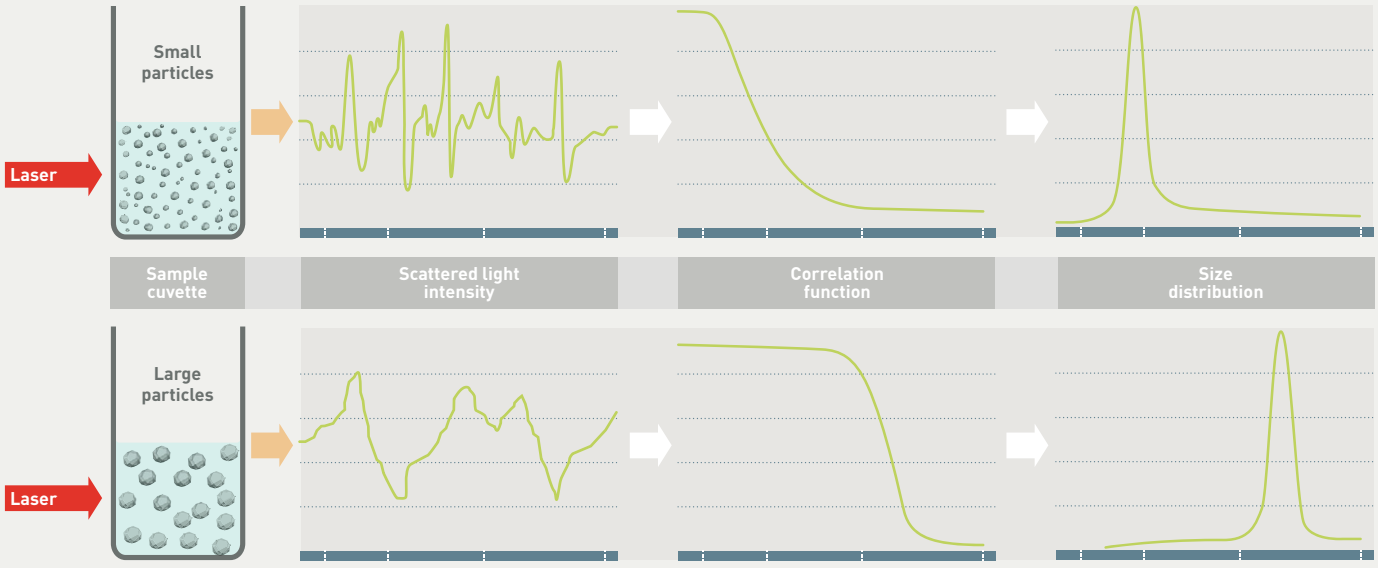
Model	Which system is right for your laboratory?	Size	Zeta potential	Molecular weight	Advanced protein measurement	Microrheology
Zetasizer Nano ZSP	The premium system for the ultimate in colloid and protein characterization	•	•	•	•	*optional*
Zetasizer Nano ZS	The World's most widely used DLS instrument	•	•	•	*optional*	*optional*
Zetasizer Nano S	The model dedicated to size measurement	•		•		
Zetasizer Nano Z	The model dedicated to zeta potential measurement		•			
Zetasizer Nano ZS90	Entry-level system providing value and versatility	•	•	•		
Zetasizer Nano S90	Entry-level size measurement system	•		•		

INTRODUCTION TO SIZE MEASUREMENT BY DYNAMIC LIGHT SCATTERING (DLS)

Why DLS is suitable for your application

The technique is ideal for the measurement of the size of colloids, nanoparticles and molecules, without requiring agitation to make the sample suitable for analysis.

From the size, an estimate of the molecular weight can be made, which has the benefit of being faster to confirm oligomeric state than size exclusion chromatography (SEC).



Measuring molecular size by DLS

The principle of dynamic light scattering is that fine particles and molecules that are in constant random thermal motion, called Brownian motion, diffuse at a speed related to their size, smaller particles diffusing faster than larger particles. The speed of Brownian motion is also determined by the temperature, therefore precision temperature control is essential for accurate size measurement.

To measure the diffusion speed, the speckle pattern produced by illuminating the particles with a laser is observed. The scattering intensity at a specific angle will fluctuate with time, and this is detected using a sensitive avalanche photodiode detector (APD). The intensity changes are analysed with a digital autocorrelator which generates a correlation function. This curve can be analysed to give the size and the size distribution.

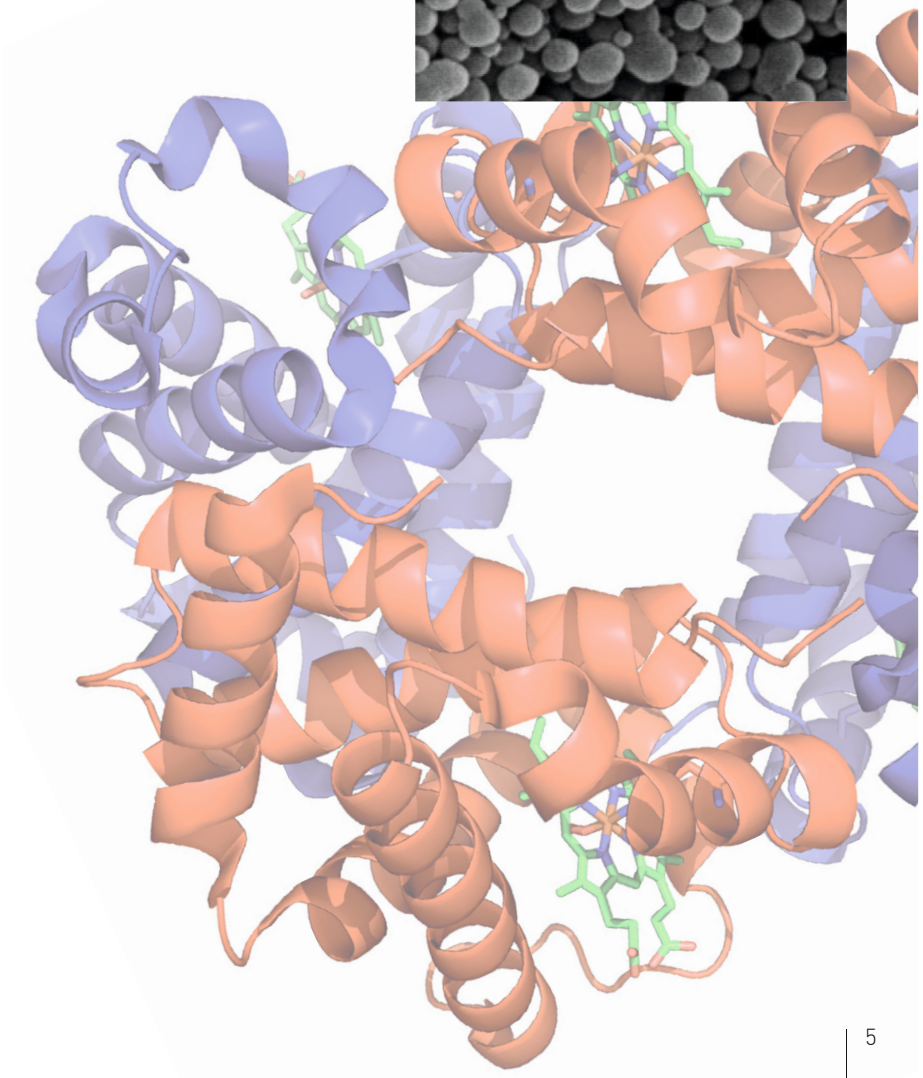
To produce high quality data, the Zetasizer Nano series is designed to provide optimized components at every stage in the measurement chain from the laser and temperature control, through to the optical design and detector.

Benefits of using the Zetasizer Nano series for DLS measurements

- Research grade results with the ease of use of a routine system
- Patented NIBS optics ensures exceptional performance
- Sample measurement with little or no dilution
- Confidence in results from unique data quality test and 'Expert advice' system
- Operator independence ensured by highly automated analysis system
- Automation of temperature trends
- MPT-2 Autotitrator to automate pH and ionic concentration trends.

NIBS: The ultimate optics for DLS measurement

The Zetasizer Nano ZSP, Nano ZS and Nano S all use the patented Non-Invasive Back-Scatter (NIBS) technology which illuminates a larger number of particles and uses efficient fibre detection, giving 100 times the sensitivity of conventional optics. Measuring a larger number of particles eliminates number fluctuations, giving a more stable signal and significantly increasing the largest particle size that can be measured.



Focus on protein solutions

One of the key application areas for the Zetasizer is the characterization of proteins in solution.

- Molecular size and aggregation behaviour
- Molecular weight by DLS and SLS
- Second virial coefficient, A_2, B_{22}
- DLS interaction parameter, k_D
- Protein charge and iso-electric point, PI
- Molecular conformation.

INTRODUCTION TO **ZETA POTENTIAL AND PROTEIN CHARGE**

The importance of zeta potential and protein charge

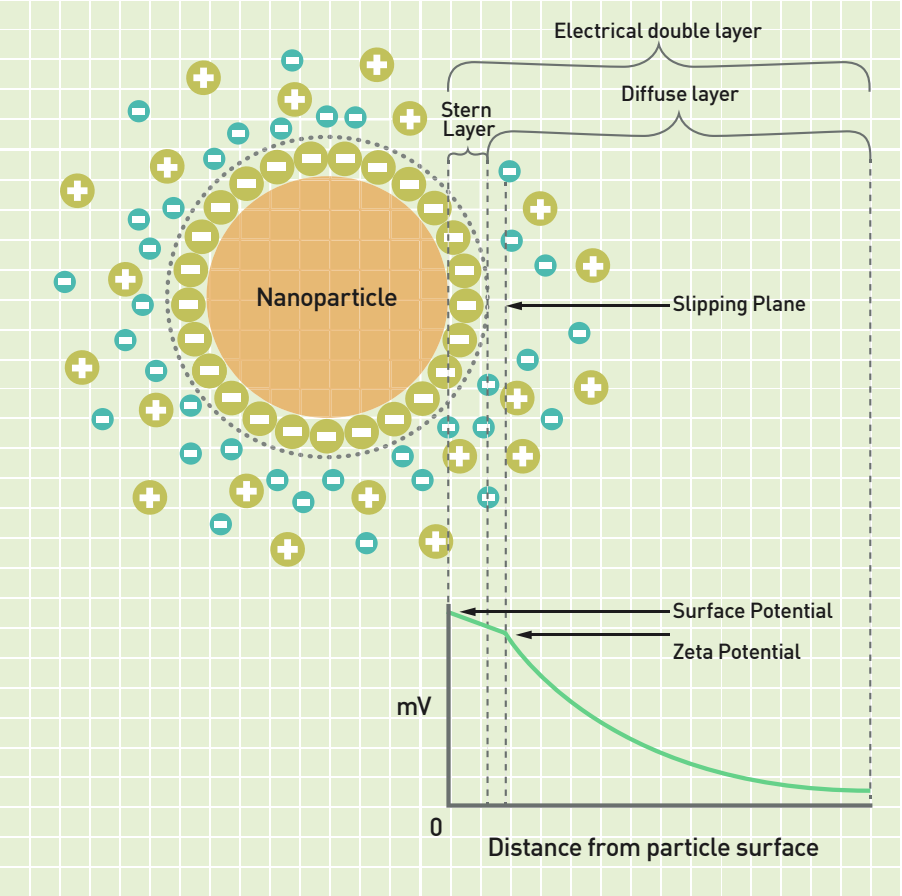
How do you approach the development of a stable dispersion or assess product shelf life?

Do you run time consuming shelf tests?

If so, there may be a better way to optimize sample stability and shelf life.

The charge acquired by a particle or molecule in a given medium is its zeta potential and arises from the surface charge and the concentration and types of ions in the solution. Since particles of similar charge will repel each other, those with high charges will resist flocculation and aggregation for longer periods making such samples more stable.

This means that the stability can be modified by altering the pH, the ionic concentration, the type of ions and by using additives such as surfactants and polyelectrolytes.



Applications

- Reducing the development time for stable dispersions and protein solutions
- Understanding the reasons for a product stability or instability, improving product shelf life
- Preventing protein aggregate formation
- Increasing protein concentration while maintaining stability
- Optimizing flocculant dosage to reduce cost for water treatment.

How we measure zeta potential

The charge or zeta potential of particles and molecules is determined by measuring their velocity while they are moving due to electrophoresis. Particles and molecules that have a zeta potential will migrate towards an electrode if a field is applied. The speed they move is proportional to the field strength and their zeta potential. If we know the field strength, we simply measure the speed of movement, using laser Doppler electrophoresis, and then apply established theories to calculate the zeta potential.

To improve the sensitivity and accuracy of the measurements we use a technique called phase analysis light scattering (PALS). However PALS on its own only provides a mean zeta potential value, so our patented M3-PALS multi-frequency measurement determines the mean and distribution during the same measurement.

The whole measurement procedure is automated to simplify the measurement process.

Why measure zeta potential?

The choices of materials used in a formulation may be restricted by regulations and also have an impact on cost. Knowledge of the zeta potential of particles in a formulation can be used to make logical choices about the chemistry of a formulation in order to select the most appropriate materials to provide stability and improve shelf life.

Zeta potential can also be used to study the effect of formulation components on other bulk properties such as viscosity, in order to achieve lower viscosity at higher concentrations for example.

Why measurement of protein charge is useful

Developing stable protein-based products, such as protein therapeutics at high concentration, demands an understanding of interactions in a range of solvent conditions.

The charge on a protein is one of the fundamental parameters that affects aspects of protein behavior such as aggregation, interaction with membranes and other surfaces, ligand binding affinity, filtration, catalytic properties, long term storage, crystallization and processing.

Measurement of the charge can provide valuable information that assists with improving a formulation in order to control these interactions, predict stability and improve shelf life.

Summary of benefits

- Fully disposable cell option to simplify measurement and ensure accuracy by eliminating cross-contamination
- Automated measurement procedure – no operator judgement required – gives repeatable, accurate results
- M3-PALS ensures an accurate zeta potential distribution
- Simple to use software with SOPs and a selection of reports
- Quality report to reduce training requirement and assist with data interpretation
- ‘Expert advice’ system to assist with optimizing the measurement procedure.

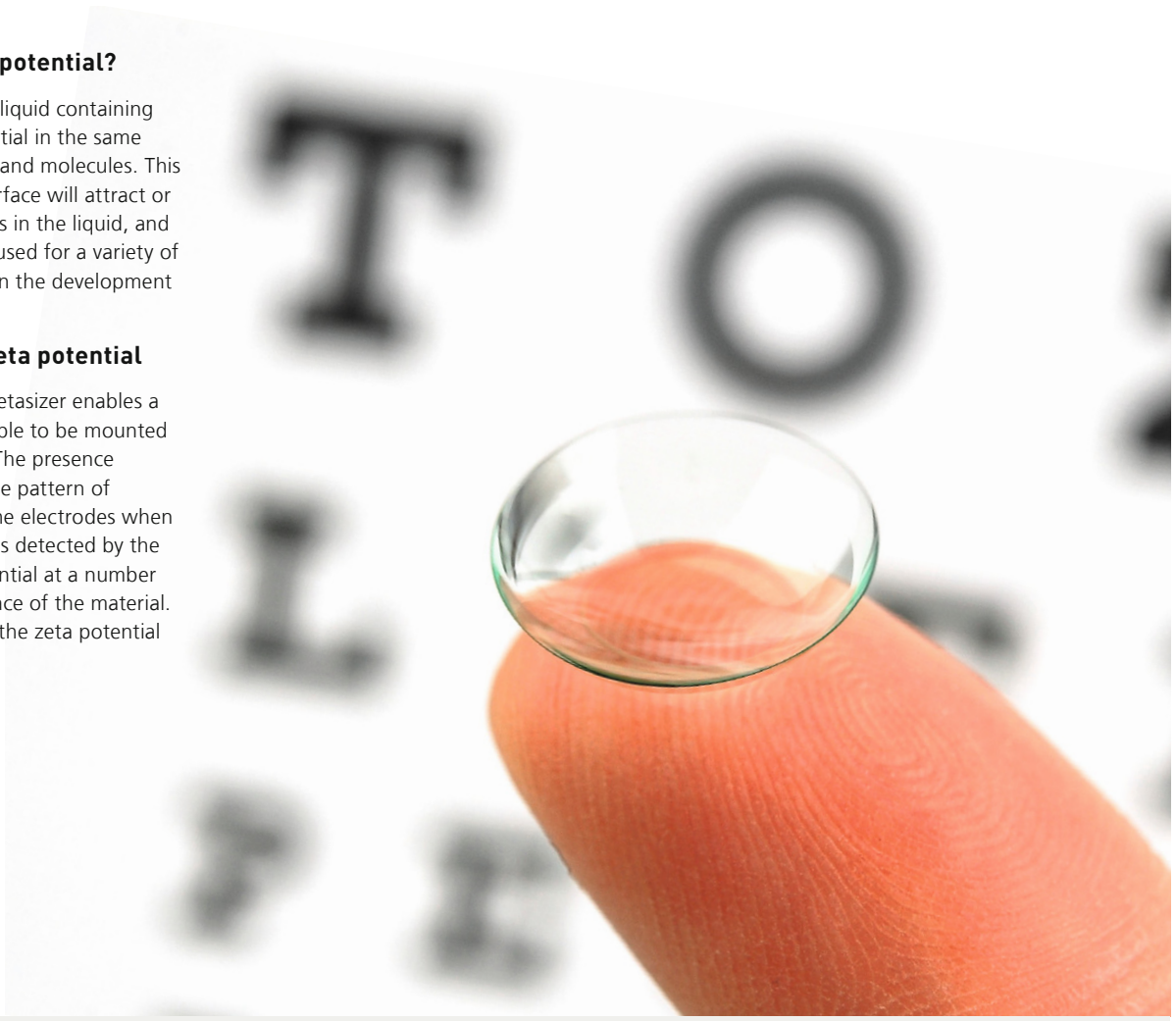
SURFACE ZETA POTENTIAL

What is surface zeta potential?

Surfaces in contact with a liquid containing ions can have a zeta potential in the same way as dispersed particles and molecules. This effective charge on the surface will attract or repel molecules or particles in the liquid, and knowledge of this can be used for a variety of applications, for example in the development of contact lenses.

Measuring surface zeta potential

An accessory cell for the Zetasizer enables a small piece of the flat sample to be mounted between two electrodes. The presence of the material modifies the pattern of electroosmosis between the electrodes when a field is applied, and this is detected by the measurement of zeta potential at a number of distances from the surface of the material. These measurements give the zeta potential at the surface.



Applications

- Filter papers used to removed charged materials such as bacteria
- Surface modification of implants to improve biocompatibility
- Functionalization of surfaces using charged polymers
- Layer-by-layer fabrication to modify optical, electronic and corrosion-resistant properties
- Improving the time between back flushes of membrane filters used for water filtration
- Controlling liquid flow in microfluidics channels
- Surface modification to control friction and adhesion.

Benefits of using the Zetasizer Nano for measuring surface zeta potential

- Uses a standard Zetasizer Nano with a surface cell accessory
- Measurement protocol and results are integrated in the standard software
- User is guided through the measurement to simplify use
- A result quality report is provided to aid data interpretation.

INTRODUCTION TO **MOLECULAR WEIGHT MEASUREMENT**

Measuring molecular weight

The Zetasizer Nano series enables you to measure the molecular weight of macromolecules in solution using Static Light Scattering (SLS). The SLS technique requires the system to be sensitive and exceptionally stable, so the Zetasizer has been designed to meet these criteria.

Molecular weight using the Zetasizer or Size Exclusion Chromatography?

- The Zetasizer measures the average molecular weight of the sample
- In comparison, SEC separates the components of a sample before the calculation of an accurate molecular weight distribution.

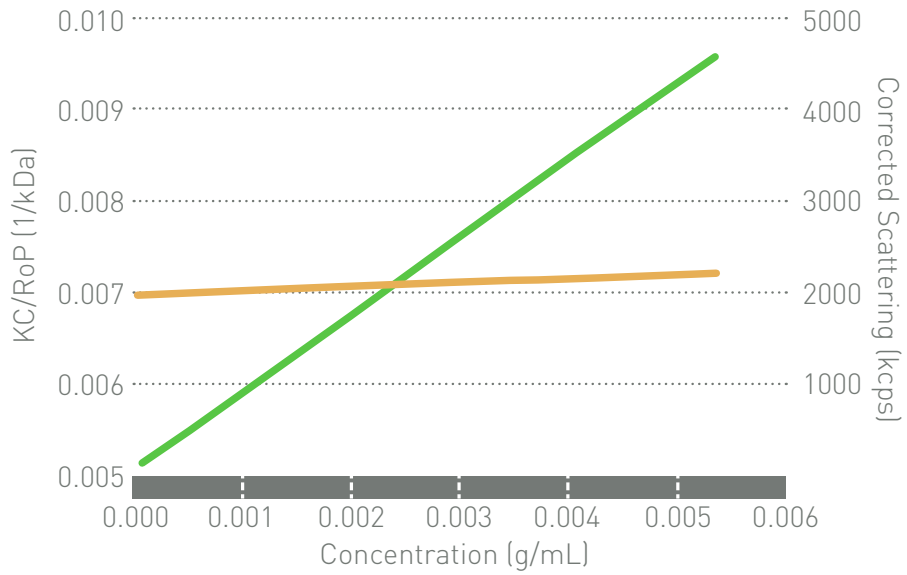
How is molecular weight measured using SLS?

SLS requires the determination of the scattering intensity of a number of known concentrations of the macromolecule in solution.

The result of this measurement is a weight-average molecular weight, and in addition the second virial coefficient, A_2 or B_{22}. This parameter is a measure of the solubility of the molecule, so is an indicator for solution stability and has been used in studies of protein crystallization.

Specifically for proteins, the same series of measurements can be used to determine the DLS interaction parameter, k_D.

Debye plot for molecular weight measurement



Benefits of using the Zetasizer Nano to measure molecular weight by SLS

- Small volume and concentration of sample required
- Calibration only requires a known pure liquid such as Toluene
- Sample can be recovered
- Second virial coefficient can be used to assess protein solubility
- Combine with size data from DLS to obtain low resolution structural information.

Microrheology

Introducing DLS-based optical microrheology

DLS-based optical microrheology uses tracer probe particles to measure the relationship between stress and deformation in materials. Analogous to mechanical rheometry, a stress is applied by Brownian motion of the tracer particle. Deformation or strain is then measured through changes in the tracer position. Thermally-driven motion of the tracer particle is intimately linked to the rheological properties of the suspending fluid. It is very different in a purely viscous medium (e.g. water) than it is in a viscoelastic medium (e.g. concentrated protein solution). From analysis of the mean square displacement (MSD) of the probe particles, rheological properties of complex fluids, such as viscosity, elastic modulus G' and viscous modulus G'' can be determined.

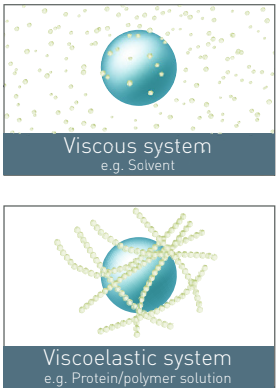
DLS Microrheology provides:

- Advanced rheological characterization on very small sample volumes down to 12µL
- Viscoelastic characterization of low viscosity, weakly-structured and highly strain-sensitive samples – measurements which can be inaccessible by mechanical rheometry techniques
- Access to very high frequency (short time) dynamics - highly relevant for dilute samples.

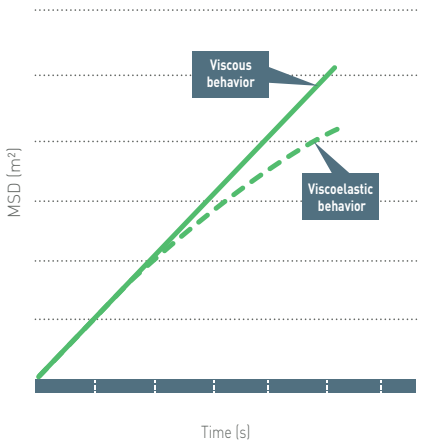
Applications

- Rheological characterization of therapeutic proteins and biopolymer solutions
- Viscoelastic measurements of protein solutions to assess onset of protein-protein interactions and insoluble aggregate formation
- Formulation development and screening
- High frequency rheology of dilute systems - application or process-relevant characterization
- Monitor structure development in complex fluids with time or temperature, or structure breakdown on dilution.

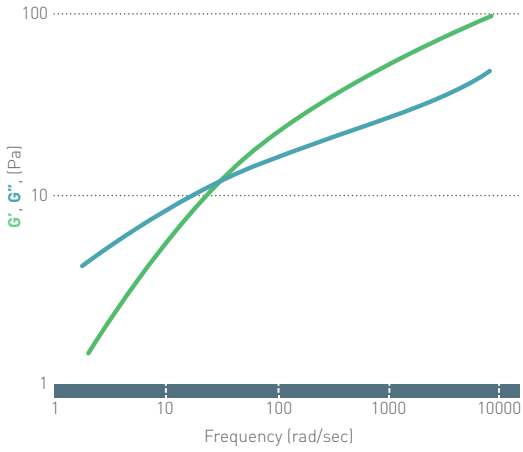
Probe particle in different environments



Schematic of Mean Square Displacement (MSD) versus time



Example of a viscoelastic spectrum derived from MSD plot for a macromolecular solution



ZETASIZER NANO CELLS AND OPTIONS

Cells

A wide range of cells are available for size, zeta potential and molecular weight measurement. These extend the applications that can be addressed to low volumes, higher concentration, non-aqueous dispersants and solvents.

Cell type	Description
Disposable folded capillary cell	Size, zeta potential and protein charge avoiding cross contamination
Dip cell	Zeta potential for aqueous and non-aqueous applications
High concentration cell	Zeta potential of samples with little or no dilution
Surface zeta potential cell	Zeta potential of material surfaces
Disposable polystyrene cell	Low cost size cell for aqueous samples
Disposable low volume polystyrene cell	Low volume size cell for aqueous samples
Glass or quartz cell	Size and MW cell for all sample types
Quartz flow cell	For use with autotitrator and chromatography systems
Ultra low volume quartz cell	Low volume size, MW cell for all sample types

Options

- Chromatography accessory kit to integrate with an SEC chromatography unit as an absolute size detector
- The MPT-2 Autotitrator and degasser automates measurements of zeta potential and size as a function of pH, conductivity or an additive
- Surface zeta potential accessory for the measurement of the zeta potential of flat surfaces
- The SV-10 Viscometer can be combined with the Zetasizer Nano for improved accuracy of DLS measurement
- Microrheology package enables viscoelastic measurements of solutions of proteins and polymers
- High temperature option to 120°C
- Narrow band filter option for fluorescent samples
- 21CFR part 11 software assists with ER/ES compliance
- Research software for the light scattering specialist.

Standard materials

- Pre-prepared zeta potential standard materials simplify routine system validation
- Size standards from the Nanosphere range are available from 20nm to 900nm and are verified against NIST certified materials.

More information at: http://www.malvern.com/labeng/products/zetasizer/accessories/mpt2.htm

NON-INVASIVE BACK-SCATTER (NIBS) SYSTEMS

ZETASIZER NANO ZSP, NANO ZS and NANO S

Parameters measured

Particle and macromolecule size, zeta potential, protein charge, surface zeta potential, molecular weight, second virial coefficient A_2, B_{22}, DLS interaction parameter k_D, protein aggregation and microrheology properties.

What is so special about these systems?

The Zetasizer series uses novel and patented technologies within the range that give unrivalled performance whilst retaining ease of use.

- Non-Invasive Back-Scatter (NIBS) increases sizing sensitivity, dynamic range and result stability
- The diffusion barrier technique improves the stability of the charge measurement of proteins, and dramatically reduces the volume of sample required
- M3-PALS improves zeta potential sensitivity and provides a distribution as well as a mean value
- Disposable cell option, including the electrodes, reduce measurement time and ensure accuracy by eliminating cross-contamination
- Precision temperature control ensures accurate and repeatable results.

Applications

- Development of nanoparticle production processes
- Shortening formulation stability development and trials
- Improving product shelf life
- Investigating the zeta potential of surfaces
- Optimising flocculant dosage in water treatment
- Optimising protein formulation for stability and minimising aggregates
- Determining protein aggregation point to investigate purity and improve shelf life.

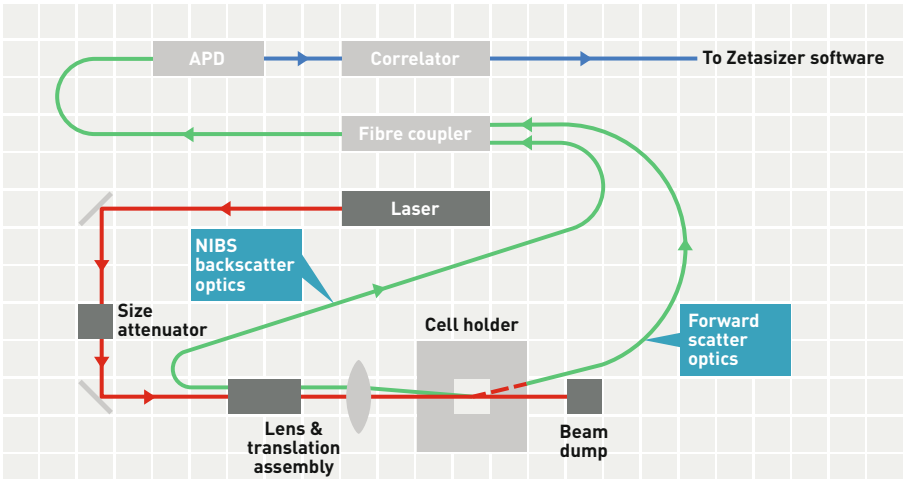
Performance

- The sensitivity to measure small and dilute samples
- The technology to measure at up to 40%w/v
- Forward scattering angle for the enhanced detection of aggregates
- Very small sample volume required
- Measurement in high salt and non-aqueous media.

Features and benefits

- Little or no dilution required to simplify sample preparation
- Wide range of sample suitability from nanoparticles to emulsions and macromolecules
- MPT-2 Autotitrator to improve productivity
- Elimination of cross-contamination using disposable cells to improve accuracy
- Data assessment using quality report and 'Expert advice' system
- Use as a chromatography detector for on-line size measurement.

The combination of the NIBS and zeta potential optics provide both back and forward scattering angles for size measurement to give an enhanced concentration range and sensitivity to aggregates.



ZETASIZER **NANO ZSP**

Get to grips with formulation development

The Zetasizer Nano ZSP is the premium member of the Zetasizer Nano series designed to provide exceptional sensitivity for the measurement of size, zeta potential and molecular weight. This is particularly important for applications where the sample is small, dilute or scatters poorly. Solutions of proteins are prime examples of this, and mean that the Zetasizer is an alternative to the use of capillary electrophoresis and isoelectric focussing for charge measurement.

Moreover, the extended protein tools have been re-designed to help you understand more about your formulation development.

Zetasizer Nano ZSP performance

- Higher power laser and new optics gives 10 times higher zeta potential sensitivity than the Zetasizer Nano ZS
- Accurately measures smaller sizes at lower concentrations
- Faster measurement times improves the efficiency of use.

ZETASIZER **NANO ZS**

What makes the Zetasizer Nano ZS so popular?

The Nano ZS has become the market leading system by providing great value and by simplifying the measurement of a range of important parameters to help make you more productive.

The NIBS optics and M3-PALS technology ensure a wide size and concentration range, which reduces your time and effort for sample preparation.

A high degree of automation of the measurement procedure means that you can be up and running in minutes, minimising the training requirement.

ZETASIZER **NANO S**

The Zetasizer Nano S is dedicated to the measurement of size and molecular weight, using the same high performance NIBS optics as the Zetasizer ZS.

Zetasizer Nano S features and benefits

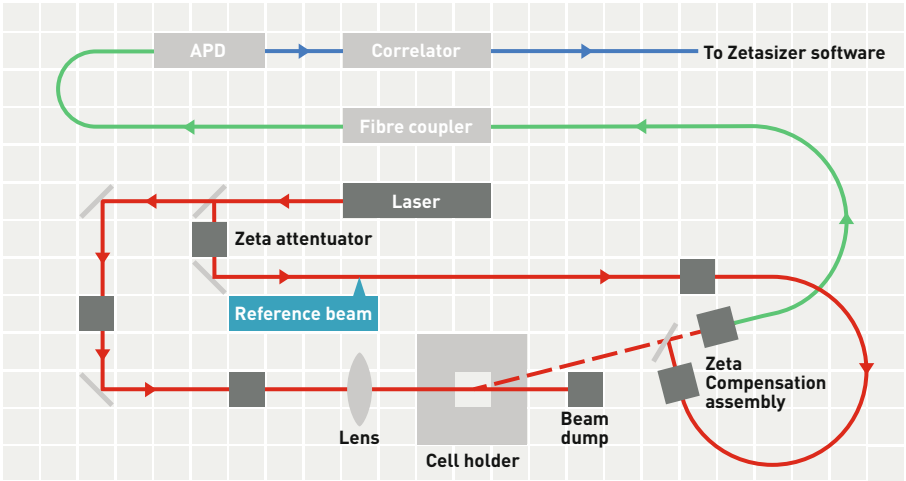
- The sensitivity to measure small and dilute samples
- Little or no dilution required to simplify sample preparation
- The technology to measure at up to 40%w/v
- Minimum sample volume of 12µL for size measurement
- Wide range of sample suitability from nanoparticles to emulsions and macromolecules
- Automation using autotitrator to improve productivity
- Data assessment using quality report and 'Expert advice' system
- Use as a chromatography detector for on-line size measurement.

ZETASIZER **NANO Z**

The Zetasizer Nano Z is dedicated to the measurement of zeta potential.

Zetasizer Nano Z features and benefits

- Measure samples up to 40%w/v
- Minimum sample volume of 20µL for zeta potential
- Measurement in high salt and non-aqueous media
- Wide range of sample suitability from nanoparticles to emulsions and macromolecules
- Automation using autotitrator to improve productivity
- Elimination of cross-contamination using disposable cells to improve accuracy
- Data assessment using quality report and 'Expert advice' system.



The zeta potential optics layout used for all zeta potential and protein charge measurements

AFFORDABLE 90° OPTIC SYSTEMS

ZETASIZER NANO ZS90 AND NANO S90

What makes the Zetasizer Nano ZS90 and S90 ideal for routine applications?

These systems incorporate 90° scattering optics that are an entry-level solution for routine applications that do not require the ultimate in sensitivity and size range.

The software benefits from all the ease of use features and developments incorporated in the rest of the Zetasizer Nano range to ensure compatibility and to minimise training.

Zeta potential with the ZS90

The zeta potential design of the ZS90 has the same capability and specification as the market leading system, the Zetasizer Nano ZS, ensuring exceptional ease of use and the same wide application range. This makes the ZS90 exceptional value for applications as diverse as nanoparticles, emulsions, pigments and biological cells.

Applications

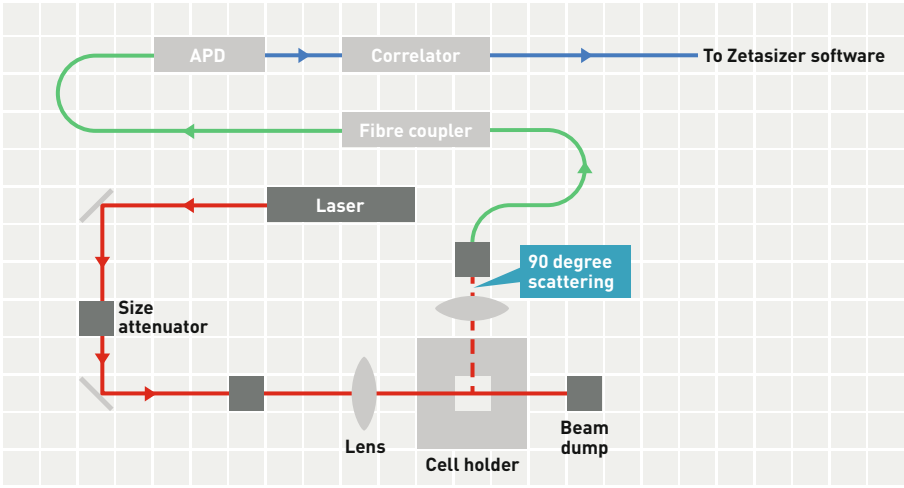
- Colloid and emulsion characterization
- Pharmaceutical dispersions and emulsions
- Liposomes and vesicles
- Basic protein analysis
- Zeta potential of particles and surfaces
- Improving ink, toner and pigment performance
- Optimising flocculant dosage in water treatment.

Zetasizer Nano ZS90 features and benefits

- The technology to measure zeta potential at up to 40%w/v (optional high concentration cell required)
- Elimination of cross-contamination using disposable cells to improve accuracy
- Minimum sample volume of 20µL for size and zeta potential
- Measurement in high salt and non-aqueous media
- Automation using autotitrator to improve productivity
- Data assessment using quality report and 'Expert advice' to reduce training.

Zetasizer Nano S90 features and benefits

- Comparable size measurements with other 90° DLS systems
- Minimum sample volume of 20µL
- Research grade correlator to cover a wide range of requirements
- Automation using autotitrator to improve productivity
- Data assessment using quality report and 'Expert advice' to reduce training
- Precision temperature control to ensure accuracy and repeatability.

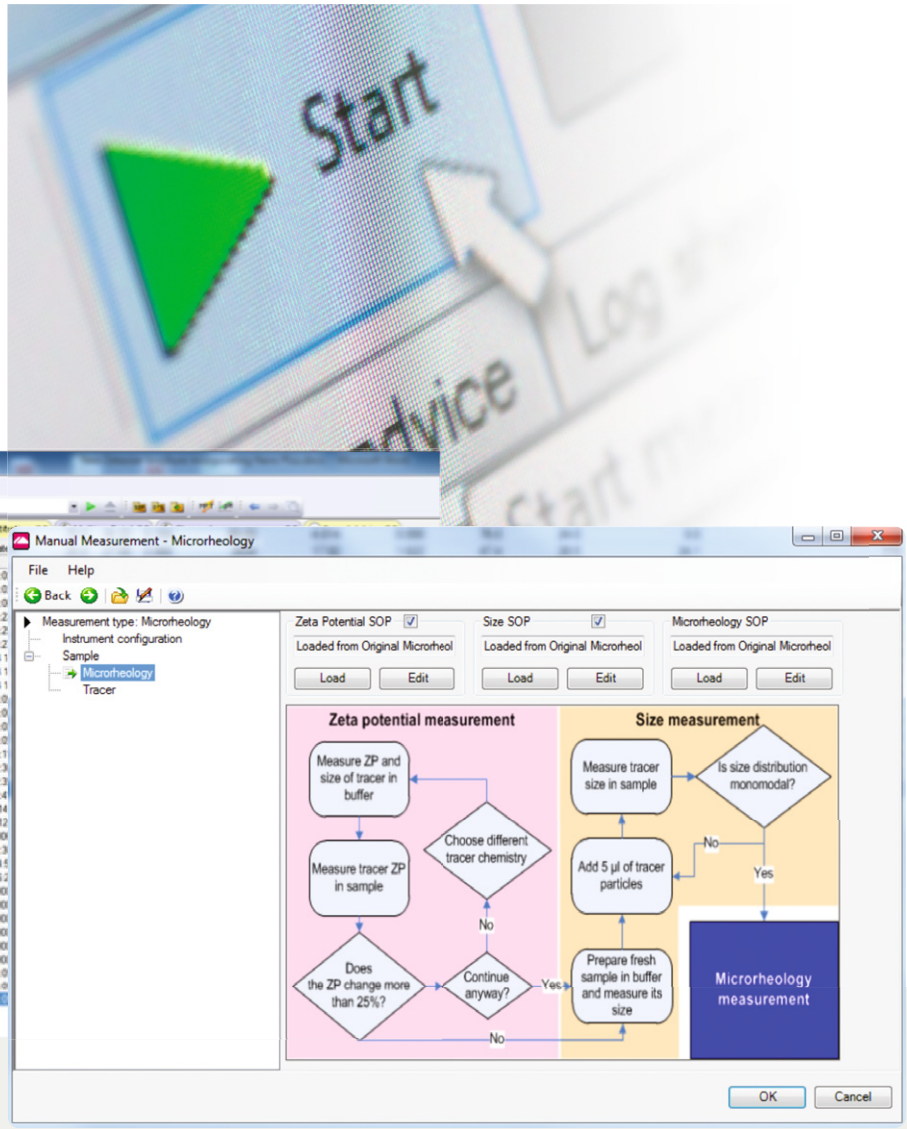


The 90° scattering size optics

THE ULTIMATE **SOFTWARE** PACKAGE

Well-designed software is paramount for the accessibility and efficiency of a system. With more than three decades of experience in developing dynamic light scattering systems, Malvern Instruments has delivered a range of versatile instruments without compromising our 'easy-to-use' ideology.

The software enables you to extract the maximum information from your sample and present the data in a clear way. The measurement procedures are highly automated, requiring minimal training to use.



The software is built on four criteria:

- Ease of measurement
- Ease of viewing data
- Ease of data interpretation
- Compliance with current standards.

Software benefits include:

- A high degree of automation so minimal training is required
- Extensive functionality without complicating the software
- Data quality report to give confidence in the result
- Expert advice software to help improve the measurement
- Workspace customisation for projects, sample types or individual personnel
- Full integration of MPT-2 Autotitrator for unattended pH or ionic strength trend measurements.

Optional software packages

- 21CFR part 11 provides support for Electronic Records/Electronic Signature (ER/ES) compliance
- Research software for the light scattering specialist
- Microrheology software for studying solution viscoeleastic properties
- Protein software for protein mobility, charge and interaction studies.

OTHER MEMBERS OF **THE ZETASIZER SERIES**

The Zetasizer family also includes the Zetasizer APS and the Zetasizer μV systems that are primarily designed for the size measurement of proteins.

Zetasizer APS

To improve DLS throughput the Zetasizer APS provides measurement automation using 96 or 384 well plates. The performance is identical to the batch capabilities of the Zetasizer μV, and ensures that reliable size measurements and thermal trends of proteins can be made unattended, improving productivity.

- Equivalent accuracy, repeatability and sensitivity of the Zetasizer μV
- Multiple measurement types from a single plate, including thermal trends
- Plate cooling option to preserve sample
- Graphical plate reporting tool to simplify data interpretation.

More information at: www.malvern.com/ZetasizerAPS

Zetasizer μV

This is a dual function dynamic light scattering system; a high sensitivity system for protein solution measurements in cuvettes, as well as an SEC detector. The system seamlessly integrates with Viscotek SEC systems via the standard OmniSEC software, as well as third party systems via the OmniFACE. This gives a real-time readout of protein size, from which molecular weight can be calculated, to give oligomer and aggregate identification without calibration.

- Light scattering detector compatible with any SEC system
- Absolute size measurement by DLS and SEC
- Absolute molecular weight of proteins by SEC
- Measure in cuvettes with a minimum of 2μL of sample.

More information at: www.malvern.com/ZetasizeruV

ZETASIZER NANO **SPECIFICATIONS**

	ZSP	ZS	S
Parameters measured	Size, Zeta potential, Molecular weight, A_2	Size, Zeta potential, Molecular weight, A_2	Size, Molecular weight, A_2
Temperature control range	0°C to 90°C +/- 0.1°C**	0°C to 90°C +/- 0.1°C**	0°C to 90°C +/- 0.1°C**
Condensation control	Purge using dry air	Purge using dry air	Purge using dry air
Standard laser	10mW, 633nm	4mW, 633nm	4mW, 633nm
Correlator	25ns to 8000s, max 4000 channels	25ns to 8000s, max 4000 channels	25ns to 8000s, max 4000 channels
Size			
Absolute sensitivity (Toluene kcps)	300	150	150
Range (Maximum diameter)	0.3nm - 10 microns*	0.3nm - 10 microns*	0.3nm - 10 microns*
Min sample volume	12µL	12µL	12µL
Min concentration, protein	0.1mg/mL 15kDa protein	0.1mg/mL 15kDa protein	0.1mg/mL 15kDa protein
Min concentration, forward angle	1mg/mL 15kDa protein	10mg/mL 66kDa protein	-
Max concentration	40% w/v*	40% w/v*	40% w/v*
Measurement angles	13° + 173°	13° + 173°	173°
Analysis algorithms***	General purpose NNLS, multiple narrow modes, protein	General purpose NNLS, multiple narrow modes, protein	General purpose NNLS, multiple narrow modes, protein
Zeta potential			
Sensitivity	1mg/mL 15kDa protein	10mg/mL 66kDa protein	-
Zeta potential range	> +/-500mV	> +/-500mV	-
Mobility range	> +/- 20 µ.cm/V.s	> +/- 20 µ.cm/V.s	-
Maximum sample concentration	40% w/v*	40% w/v*	-
Minimum sample volume (using diffusion barrier)	20µL	20µL	-
Maximum sample conductivity	200mS/cm	200mS/cm	-
Signal processing	M3-PALS	M3-PALS	-
Molecular weight			
Molecular weight range (estimated from DLS)	<1000Da - 2 x 10^7Da*	<1000Da - 2 x 10^7Da*	<1000Da - 2 x 10^7Da*
Molecular weight range (Debye plot)	<1000Da - 2 x 10^7Da*	<1000Da - 2 x 10^7Da*	<1000Da - 2 x 10^7Da*
Accessories			
MPT-2 Autotitrator and degasser	■	■	■
Dip cell	■	■	-
High concentration cell	■	■	-
Surface zeta potential cell (sample 5mm x 4mm)	■	■	-
SV-10 viscometer	■	■	■
High power laser, 50mW, 532nm	-	■	■
High temperature range, 120°C	-	■	■
Narrow band fluorescence filter	■	■	■
Chromatography option	■	■	■
21 CFR part 11 software	■	■	■
Microrheology software	■	■	-
Advanced protein measurement software	Included	■	-
Research software	■	■	■
Dimensions			
D x W x H, mm (Weight)	600 x 320 x 260 (19kg)	600 x 320 x 260 (19kg)	600 x 320 x 260 (19kg)

Notes

* sample dependent ** 0.1° at 25°C, 0.2° at 2°C, 0.5° at 90°C *** Contin algorithm in research software option ■ Optional accessory, purchased separately.

Z	ZS90	S90	
Zeta potential	Size, Zeta potential, Molecular weight, A_2	Size, Molecular weight, A_2	Parameters measured
0°C to 90°C +/- 0.1°C**	0°C to 90°C +/- 0.1°C**	0°C to 90°C +/- 0.1°C**	Temperature control range
Purge using dry air	Purge using dry air	Purge using dry air	Condensation control
4mW, 633nm	4mW, 633nm	4mW, 633nm	Standard laser
25ns to 8000s, max 4000 channels	25ns to 8000s, max 4000 channels	25ns to 8000s, max 4000 channels	Correlator
			Size
-	2	2	Absolute sensitivity (Toluene kcps)
-	0.3nm - 5 microns*	0.3nm - 5 microns*	Range (Maximum diameter)
-	20µL	20µL	Min sample volume
-	10mg/mL 15kDa protein	10mg/mL 15kDa protein	Min concentration, protein
-	-	-	Min concentration, forward angle
-	Dilute	Dilute	Max concentration
-	13° + 90°	90°	Measurement angles
-	General purpose NNLS, multiple narrow modes, protein	General purpose NNLS, multiple narrow modes, protein	Analysis algorithms ***
			Zeta potential
10mg/mL 66kDa protein	10mg/mL 66kDa protein	-	Sensitivity
> +/-500mV	> +/-500mV	-	Zeta potential range
> +/- 20 µ.cm/V.s	> +/- 20 µ.cm/V.s	-	Mobility range
40% w/v*	40% w/v*	-	Maximum sample concentration
20µL	20µL	-	Minimum sample volume (using diffusion barrier)
200mS/cm	200mS/cm	-	Maximum sample conductivity
M3-PALS	M3-PALS	-	Signal processing
			Molecular weight
-	<1000Da - 2 x 10^7Da*	<1000Da - 2 x 10^7Da*	Molecular weight range (estimated from DLS)
-	<10,000Da - 2 x 10^7Da*	<10,000Da - 2 x 10^7Da*	Molecular weight range (Debye plot)
			Accessories
■	■	■	MPT-2 Autotitrator and degasser
■	■	-	Dip cell
■	■	-	High concentration cell
■	■	-	Surface zeta potential cell (sample 5mm x 4mm)
■	■	■	SV-10 viscometer
■	■	■	High power laser, 50mW, 532nm
■	■	■	High temperature range, 120°C
■	■	■	Narrow band fluorescence filter
-	■	■	Chromatography option
■	■	■	21 CFR part 11 software
-	-	-	Microrheology software
-	-	-	Advanced protein measurement software
■	■	■	Research software
			Dimensions
600 x 320 x 260 (19kg)	600 x 320 x 260 (19kg)	600 x 320 x 260 (19kg)	D x W x H, mm (Weight)

Notes

* sample dependent ** 0.1° at 25°C, 0.2° at 2°C, 0.5° at 90°C *** Contin algorithm in research software option ■ Optional accessory, purchased separately.

Malvern Instruments Limited
Grovewood Road, Malvern,
Worcestershire, UK, WR14 1XZ

Tel +44 1684 892456
Fax +44 1684 892789
www.malvern.com

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Patents:

Non-Invasive Back Scatter (NIBS)
US6016195, JP11051843, EP884580

High and Low Frequency Electrophoreses (M3)
EP1154266, JP04727064, US7217350

Light Scattering Measurements using Simultaneous Detection
EP2235501, CN102066901, JP2011523451, US20090251696

Surface Potential Determination in a Dip Cell
WO2012172330

MRK1839-03