HORIBA
Scientific

Nanoparticle Analyzer
nano partica SZ-100series

Industry's Widest Range and Highest Precision Measurement Instrument for Nano-particle Characterization "nano partica SZ-100"

ISO9001 JQA-0298
ISO14001 JQA-E-90099
IMS
HORIBA is operating Integrated Management System
OHSAS18001 JQA-OH0068
ISO13485 JQA-MD0010

A highly advanced analyzer solves the mysteries of the nano-world. A single device analyzes the three parameters that characterize nanoparticles: particle diameter, zeta potential, and molecular weight.

Newly developed to satisfy the need for devices to simply and accurately evaluate the size and dispersion stability of nanoparticles, the key to nanotechnology advancement:

nano partica SZ-100 Series Nanoparticle Analyzer

The nano technology research and development of controlling substances at the atomic and molecular level in order to achieve new functionality and scalability is continuously evolving.
The miniaturization of components – that is, control at the nanolevel – is necessary to achieve faster, higher-performance devices and functions and to reduce energy consumption. Nanotechnology has come to play a key role in wide-ranging fields that affect our daily lives, including food, cosmetics, and the life sciences.

Clear and simple multi-element analysis of nanoparticles! Three analyzers in a single compact body deliver high-sensitivity, high-accuracy analysis of each measurement parameter.

Particle Diameter Measurement Range *0.3nm to 8μm*

The SZ-100 Series measures particle diameter and particle distribution width, realizing this wide dynamic range by means of photon correlation spectroscopy.
Analysis across a wide range of sample concentrations: Measurement of samples ranging from low ppm-order concentrations to high-concentration samples in double-digit percentages is possible. Accepts commercially available sampling cells. Analysis of small-volume samples is also possible.

Zeta Potential Measurement *−200 to +200mV*

Analysis of sample volumes as small as 100μL using HORIBA-developed microelectrophoresis cells.

Molecular weight 1×10^3 *to* 2×10^7 *g/mol*

Absolute molecular weight (Mw) and the second virial coefficient (A_2) are obtained by performing static light scattering measurement while changing sample concentration and preparing Debye plots.

The SZ-100 Series applies sophisticated intelligence and learning capability to rapidly determine nanoparticle properties!

- Since the SZ-100 Series analyzer covers a wide sample concentration measurement range, sample dilution and other preprocessing is nearly eliminated.
  The use of a dual optical system enables measurement of high-concentration samples such as slurry and ink pigments as well as low-concentration proteins and polymers.
- A single device analyzes the three parameters that characterize nanoparticles: particle diameter, zeta potential, and molecular weight.
- HORIBA-developed disposable cells for zeta potential measurement prevent sample contamination.
  Simple analysis by means of ultra micro-volume dedicated cells (volume as low as 100μL). Suitable for analysis of dilute samples.

nano partica SZ-100

Simple and Convenient Operation

Simply fill the sample cell and place the cell in the analyzer.

A space-saving body design makes the analyzer suitable for installation in any laboratory environment.

Operation Procedure

[Sampling]

Fill the sample cell.

[Cell Set-Up]

Place the cell in the analyzer.

[Start of Measurement]

Click the Start Measurement button.

[Results Display]

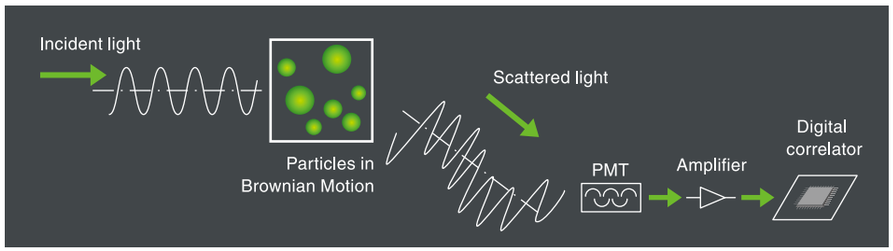
The measurement results are displayed.

Maintenance-Free

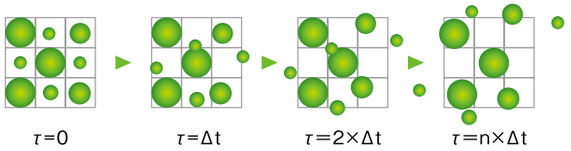
No maintenance or cleaning of the analyzer is required. After measurement, simply clean or dispose of the cell.

Particle Diameter Measurement Principle

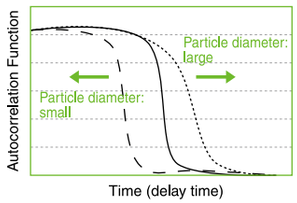
Dynamic light scattering is a method of measuring the size of minute particles. Dispersed particles suspended in solution moving due to Brownian motion are irradiated with laser light, and light scattered from the particles is detected using a photomultiplier tube (PMT). The larger the particle, the slower the Brownian motion will be, and the smaller the particle, the faster the Brownian motion will be. Accordingly, light scattered from the particles is detected as a signal with fluctuation corresponding to the speed of Brownian motion. The signal obtained is analyzed using photon correlation spectroscopy, the autocorrelation function is calculated, and particle diameter and distribution are calculated.



Graphic Rendering of Minute Particle



The Relationship Between the Autocorrelation Function and Particle Diameter



Calculation of the autocorrelation function* involves comparison of the difference between scattered light intensity at a time (τ) and intensity at times after τ. Since the larger the particle, the slower the motion is, for large particles motion (change) after time τ is small, and the result is a gradual decay curve. Since the smaller the particle the faster and more active the motion is, the result for small particles is a large change after time τ. (See the chart above.)
The pattern change resulting from this particle motion is quantified as a diffusion coefficient, and particle diameter (d) is calculated from the dispersion coefficient using the Stokes-Einstein equation. (See the equation below.)

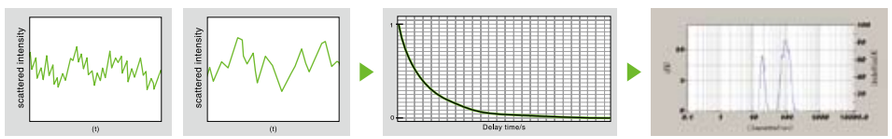
* The autocorrelation function is the change over time in scattered light intensity fluctuation represented by a quadratic function. It compares scattered light intensity at a given time (τ) and intensity after time τ.

Calculate particle diameter (d) from the dispersion coefficient using the Stokes-Einstein equation.

$$G_2(\tau) = exp(^{-}2Dq^2\tau)^{+} 1$$ ····· Quadratic autocorrelation coefficient equation

$$d = kT/3\pi\eta D$$ ····· Stokes-Einstein equation

D :Dispersion coefficient k :Boltzmann constant q :Scattering vector T :Absolute temperature τ :Delay time
η :Dispersion medium viscosity d :Particle diameter



Small particle light fluctuation signal | Large particle light fluctuation signal | Autocorrelation function | Particle distribution

◎ Features of HORIBA's Original Optical System

1 Use of High-Sensitivity Optical Components

The key to accurately and rapidly evaluating the size and state of dispersion of nanoparticles is to either use a high-energy laser light source or to increase detector sensitivity. HORIBA uses the most highly sensitive photomultiplier tubes available as sensors. Since energy intensity is inversely proportional to the fourth power of the scattered light wavelength is obtained, the use of a short-wavelength light source helps in obtaining a sufficient signal from short-time measurement. However, the use of light in the ultraviolet region, which has an even shorter wavelength, must be limited to certain applications since ultraviolet light causes a chemical reaction or generates fluorescence with some substances.

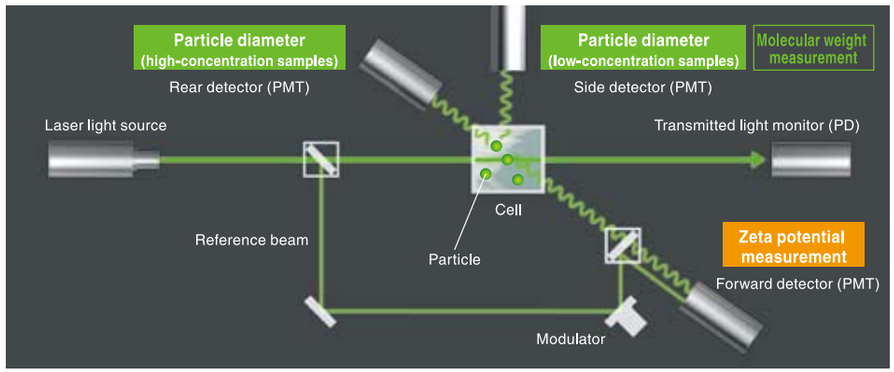
2 Conformance with Standards

The SZ-100 Series analyzer incorporates photon correlation spectroscopy that conforms to ISO 13321:1996 and JIS Z8826:2005 standards.

3 Automatic Selection Function for Optimal Measurement Conditions

The analyzer has a function to measure the transmitted light intensity of the laser beam and automatically select an appropriate detector when an unknown sample has been loaded.

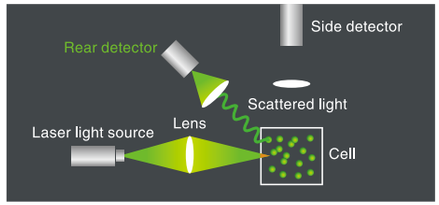
A HORIBA Innovation Enables Analysis of a Wide Range of High-Concentration and Low-Concentration Samples



The optical configurations shown below automatically selects the detection angle in accordance with the concentration of the analyzed sample.

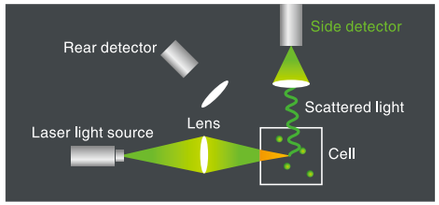
[High-Concentration Samples]

For high-concentration samples, to avoid the effect of multiple scattering, the analyzer detects back-scattered light on the vicinity of the cell surface using the rear detector.



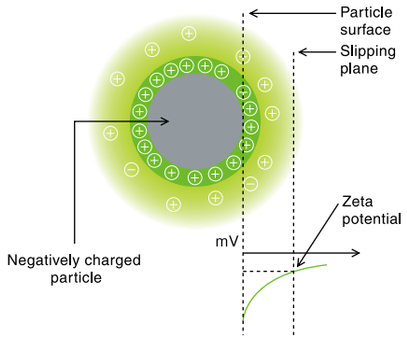
[Dilute Samples]

For dilute samples, the analyzer selects the side detector and performs measurement with a high signal-to-noise ratio by detecting signals with few noise components that become stray light.



The Zeta Potential Measurement Principal
(Laser Doppler Electrophoresis)

Minute particles or colloids dispersed in solution carry either a positive or negative electrical charge. They are surrounded by ions having the opposite charge and undergo thermal motion. When an electric field is introduced to a solution, the particles move in the potential direction opposite to their charge. Particle motion velocity is proportional to the electrical charge quantity. When a solution is irradiated with light at the time of particle motion, scattered light that has created a Doppler shift corresponding to the motion velocity is observed. The Doppler shift amount is proportional to the motion velocity. In other words, the potential at the slipping plane (= zeta potential) is measured by detecting the amount of frequency change in scattered light. Particle analyzers measure zeta potential as an index for ascertaining the surface state of minute particles. The analysis results are beneficial for improving minute particle dispersibility and functionality.



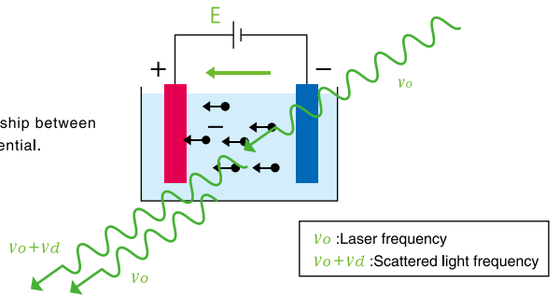
◎ Electrophoresis

Although several methods of measuring zeta potential have been established, HORIBA's nano partica analyzer uses electrophoresis. With this method, sample particles suspended in a solvent (solvent refraction index = n) are irradiated with laser light (wavelength = λ) and an electric field (voltage = E) is applied. When the frequency shift at angle θ is measured once the electric field is applied, the following relationship between particle motion velocity (V) and mobility (U=V/E) is formed.

$$U = \frac{\lambda \cdot \nu d}{2 \cdot E \cdot n \cdot \sin(\theta/2)}$$

The following equation is used for the relationship between the calculated electrical mobility and zeta potential.

$$\zeta = \frac{U\eta}{\varepsilon \cdot f(\kappa a)}$$



ζ :Zeta potential U :Electrical mobility E :Voltage n :Solvent refraction index ε :Solvent dielectric constant η :Solvent viscosity
f(κa) :Henry coefficient

The analyzer uses a heterodyne optical system to observe particle motion velocity and calculate electrical mobility from the resulting frequency intensity distribution.

1 Sampling measurement using the industry's lowest sample volume of 100 µL is possible.

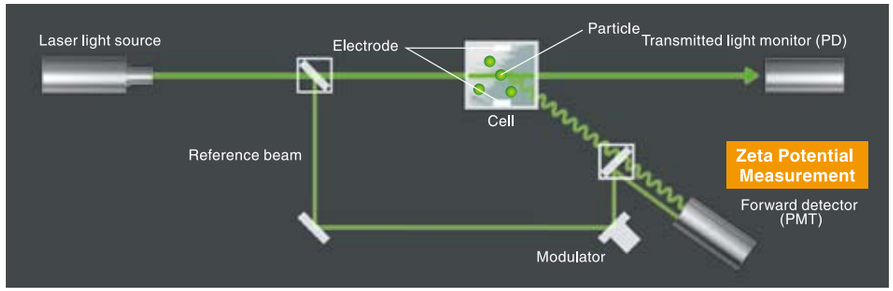
2 Arithmetic processing from an autocorrelation function by a Fourier transformation to electrical mobility that draws fully on HORIBA's accumulated experience

3 A Mean to Highly Accurate, Highly Reproducible Measurement: Electro-osmotic Flow Countermeasure

In zeta potential measurement, when a sample dispersed in a liquid is placed in a capillary cell and an electric field is applied, a phenomenon occurs in which the liquid moves in parallel with the movement of the dissolved substance and charged particles (electrophoresis). Ions having the opposite charge to the charged particles collect on the cell wall. When the electric field is applied, a flow occurs by which the ions move in the direction of the opposite pole, and a flow in the opposite direction of that flow occurs in the vicinity of the cell center. This flow is called electro-osmotic flow. Since electro-osmotic flow affects electrophoresis, it must be taken into account in order to achieve accurate zeta potential measurement.

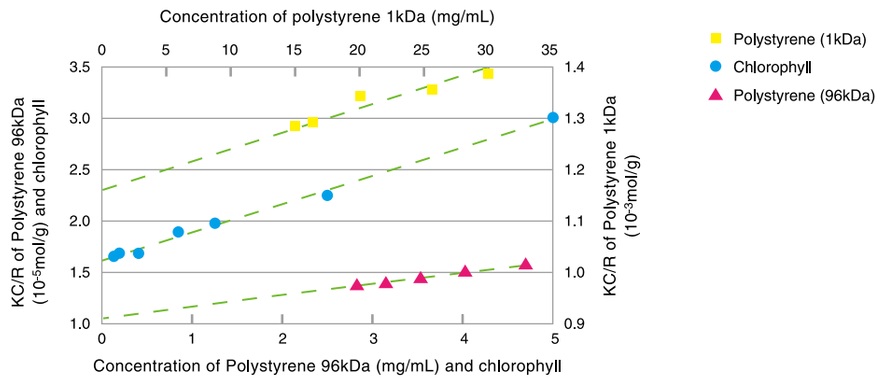
HORIBA has increased measurement accuracy by developing original sealed cubic cells little affected by electro-osmotic flow.

When reversing the flow, the analyzer briefly applies a condition of constant-velocity particle motion and prevents hindrance of particle motion by creating an uncharged state and a state unaffected by heat to stop the electro-osmotic flow.



Molecular Weight Measurement Principle

The SZ-100 series analyzer calculates absolute molecular weight by performing static light scattering measurement while changing sample concentration and using Debye plots. This method is suitable for measurement of a wide range of particles, even biological macromolecules such as synthetic macro-molecules and proteins.
Diameter measurement using dynamic light scattering can also be performed for the same sample.
The chart below shows representative measurement examples for several standard samples.



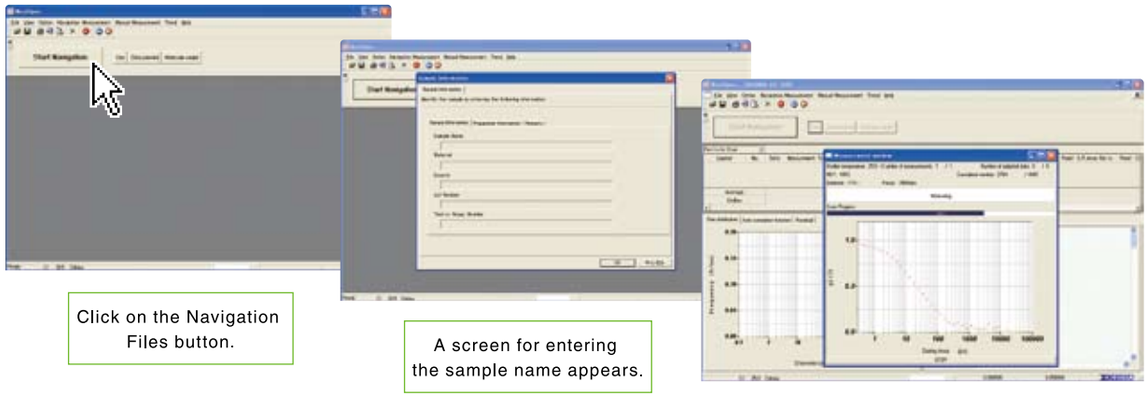
Analysis Tools

Simple and Convenient Operation/Software Functions

The operator selects a measurement mode (particle diameter, zeta potential, or molecular weight), loads the sample when the measurement screen appears, and begins measurement. The SZ-100 Series offers the ultimate in clear, simple operability.

Quick and Simple Operation Using Navigation

Measurement begins in accordance with the measurement conditions configured using the navigation function, and the measurement results are automatically displayed. Operation is as simple as clicking on buttons.



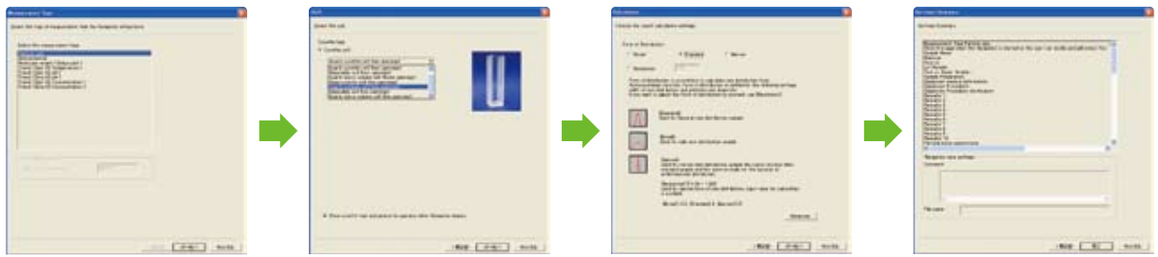
Click on the Navigation Files button.

A screen for entering the sample name appears.

Measurement begins upon completion of entry.

Navigation Creation Is Simple.

Once appropriate sample measurement conditions and procedures have been decided in accordance with the purpose of analysis, create a navigation button.



First, select the measurement item (particle diameter, zeta potential, or molecular weight).

Select a sampling cell for use in measurement.

Select the operation conditions.

Assign a name to the prepared navigation file and save the file to complete the process.

The software follows a progression of selecting measurement conditions and procedures and creates a navigation file.

Measurement Accuracy and Performance Guarantee

HORIBA confirms measurement performance prior to product shipment, using HORIBA-approved standard samples to confirm accuracy and reproducibility as per the tables below. To ensure high-level, stable performance, HORIBA delivers products manufactured in accordance with rigorous quality control systems worldwide.

Particle diameter

Particle diameter measurement accuracy calibrated using NIST-traceable polystyrene latex standard particles is as shown below.

Particle diameter standard value (nm)	Concentration	Standard
100nm	100ppm	Measured values for cumulant average diameter are within ±2%. (This does not include variation in the standard particles themselves.)

Particle diameter measurement reproducibility is as shown below.

Particle diameter standard value (nm)	Concentration	Standard
100nm	100 ppm	The CV value for 6 repeated measurements is less than 2%.
100nm	10 wt.%	The CV value for 6 repeated measurements is 5% or less.

*Conforms to ISO 13321: 1996, ISO 22412 : 2008 and JIS Z 8826: 2005.

Zeta Potential

Using a HORIBA-designated colloidal silica sample, HORIBA confirms that accuracy is –25 mV of the standard value or less. Reproducibility for 6 repeated measurements is a CV value of 10% or less.

Molecular Weight

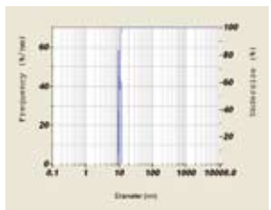
The measured value is within ±10% of the standard value calibrated using a polystyrene standard sample (96,000 g/mol).

Applications

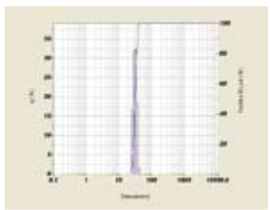
Biomaterials: Gold colloid particle diameter measurement results

Au colloids (NIST)	RM8011 (10 nm), 8012 (30 nm), 8013 (60 nm)
Nominal diameter	13.5 nm, 26.5 nm, 55.3 nm

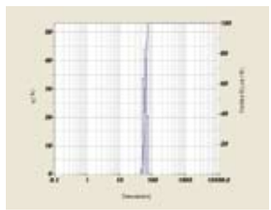
	RM8011	RM8012	RM8013
Average diameter (nm)	10.3	30.8	59.7



RM8011

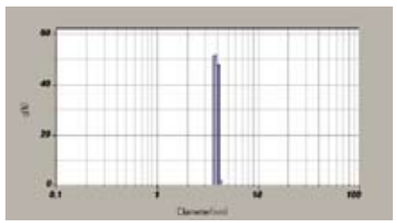


RM8012



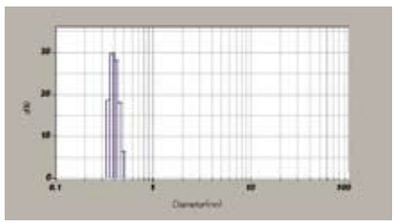
RM8013

Lysozyme (from egg white) particle diameter measurement result(Molecular weight: approx. 14,000)



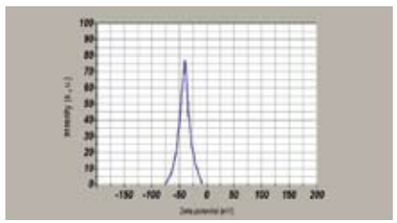
Sample concentration: 0.1mg/mL
Acetic acid buffer: pH=4.3
Average diameter: 4.0 nm

Thiamin hydrochloride (Vitamin B1 hydrochloride) particle diameter measurement result (Molecular weight: approx. 337)



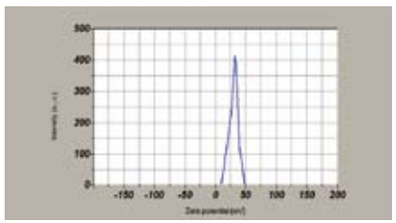
Sample concentration: 300 mg/mL
Average diameter: 0.4 nm

LUDOX SiO_2 zeta potential measurement result



Sample concentration: Adjusted to 10 wt% using a 0.01 mol/L KCl solution
Zeta potential: -38.3 mV

NIST SRM 1980 α-FeOOH zeta potential measurement result

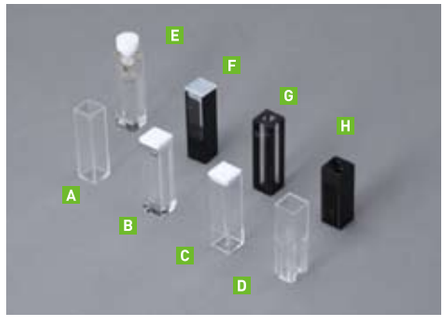


Sample concentration: 50 ppm, pH = 2.5
Mobility (rated): 2.53 ± 0.12 μm·cm/Vs
Measurement results: Mobility = 2.53 μm·cm/Vs; Zeta potential = 32.9 mV

Accessories

Sampling Cell Types and Specifications

Select from a full line of sampling cells according to sample volume and solvent.



Zeta potential measurement disposable cells
(For zeta potential and particle diameter measurement, 100 μL, Aqueous)

	Cell Name	Measurement Application	Minimum Sampling Volume	Solvent
A	Disposable cell	Particle diameter/ Molecular weight	1.2 mL	Aqueous
B	Semi-micro cell		500 μL	Aqueous, Non-aqueous
C	Glass cell		1.2 mL	Aqueous, Non-aqueous
D	Semi-micro disposable cell		600 μL	Aqueous
E	Cell with lid		1.2 mL	Aqueous, Non-aqueous
F	Micro-cell (Side detector only)		12 μL	Aqueous, Non-aqueous
G	Sub-micro cell		200 μL	Aqueous, Non-aqueous
H	Flow cell		100 μL	Aqueous, Non-aqueous

pH Controller

This is an accessory that adjusts sample pH by performing automatic titration. It is optimal for evaluation of particle diameter and zeta potential change and stability.

pH Controller Accessory Specifications

- No. of titrant bottles: max. of 2 types
- Sample flow velocity: approx. 30-80 mL/min.
- Sample solution volume: 50-200 mL
- pH adjustment range: 1-13
- Power supply: AC 100-120/200-240 V, 50/60 Hz, 45 VA
- Dimensions and weight:
  Body: 468 (D) x 288 (W) x 481 (H) mm, approx. 12 kg
  Stirrer: 225 (D) x 118 (W) x 336 (H) mm, approx. 2.1 kg
  Circulation pump: 202 (D) x 124 (W) x 122 (H) mm, approx. 1.7 kg

SZ-100-S Measurement Specifications

Model	SZ-100-S (particle diameter and molecular weight measurement only)
Measurement principles	Particle diameter measurement: photon correlation spectroscopy Molecular weight measurement: Debye plot method (static scattered light intensity)
Measurement range	Particle diameter: 0.3 nm to 8 µm Molecular weight: $1x10^3$ to $2x10^7$ g/mol
Particle diameter measurement accuracy	Measurement accuracy of ±2% for NIST traceable polystyrene latex 100 nm spheres (not including variation in the standard particles themselves)
Cells	Cuvettes
Measurement time	Approx. 2 min. under ordinary conditions (from the start of measurement to the display of results for particle diameter measurement)
Required sample volume	Minimum volume of 10 µL*1 to 1.2 mL (differs depending on cell material)
Carrier fluids	Water, ethanol, organic solvents

*1 :HELLMA fluorescence cell no. 105.252-QS. h=8.5 mm, op 1010 mm

SZ-100-Z Measurement Specifications

(Particle diameter and molecular weight measurement specifications are the same as for the SZ-100-S.)

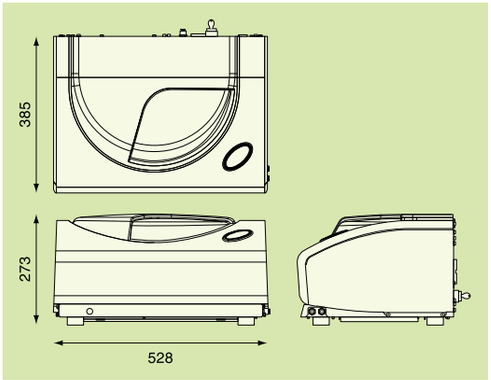
Model	SZ-100-Z (with zeta potential measurement unit)
Measurement principle	Zeta potential measurement: Laser Doppler electrophoresis
Measurement range	-200 to +200 mV
Cells	Dedicated cell with electrodes
Measurement time	Approx. 2 min. under ordinary conditions
Required sample volume	100 µL
Carrier fluids	Water, ethanol, organic solvents

* Composite photographs are inserted into the PC screens.

Analyzer Specifications (SZ-100-S and SZ-100-Z)

Measuring unit optical system	Light source: Semiconductor laser excitation solid laser (532 nm, 10 mW) Detectors: Photomultiplier tubes (PMT)
Laser classification	Class I
Operating temperature and humidity	15-35°C, RH85% or less (no condensation)
Holder temperature control temperature settings	1-90°C (up to 70°C for cells with electrodes and plastic cells)
Purging	Nitrogen tube connection is possible.
Power supply	AC 100-240 V, 50/60 Hz, 150 VA
Dimensions	385 (D) x 528 (W) x 273 (H) mm (excluding protrusions)
Weight	25 kg
Personal computer	Windows XP or Vista compatible IBM PC/AT type computer
Interface	USB 2.0 (between measuring unit and PC)
OS	Windows® XP or Vista™ (Japanese Windows® XP or Vista™ required for Japanese-language display)
Printer	Windows® XP or Vista™ compatible printer
Operation method	Input using mouse and keyboard in the Windows® XP or Vista™ environment

Dimensions (mm)



Class I laser product

☐ Data Processing

Navigation files turn complex parameter input into simple to use operating procedures. / Store 100 data items on a data list. / Display individual data items with a single mouse click. / Perform pH, temperature, and sample concentration trend measurement.

☐ Particle Diameter Measurement

Real-time display of the autocorrelation function / Display of median diameter, specific surface area, mode diameter, average diameter, standard deviation, coefficient of variation, span value, percentage diameter (max. of 10 items), Z average, polydispersity index, diameter percentage (max. of 10 items displayed) / Particle distribution graph, autocorrelation function, residual error / Refractive index, viscosity, computing range, and data recalculation due to change in convergence properties

☐ Molecular Weight Measurement

Molecular Weight Measurement
Real-time display of Debye plots / Display of molecular weight and the second virial coefficient / Recalculation of Debye plot graph display data

☐ Zeta Potential Measurement

Zeta potential, standard deviation, electrophoretic mobility, and average zeta potential at each peak / Display of zeta potential graphs, mobility graphs, recalculation of data

☐ Options

21CFR Part 11 software / Zeta potential measurement organic solvent cells / pH control unit / IQ/OQ/PQ support

Horiba continues contributing to the preservation of the global environment through analysis and measuring technology.

Please read the operation manual before using this product to assure safe and proper handling of the product.

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