MICROTRAC MRB

PARTICLE CHARACTERIZATION

NANOTRAC SERIES

NANOPARTICLE SIZE & ZETA POTENTIAL

DYNAMIC LIGHT SCATTERING MADE EASY WITH PROBE TECHNOLOGY

part of VERDER scientific

MICROTRAC MRB

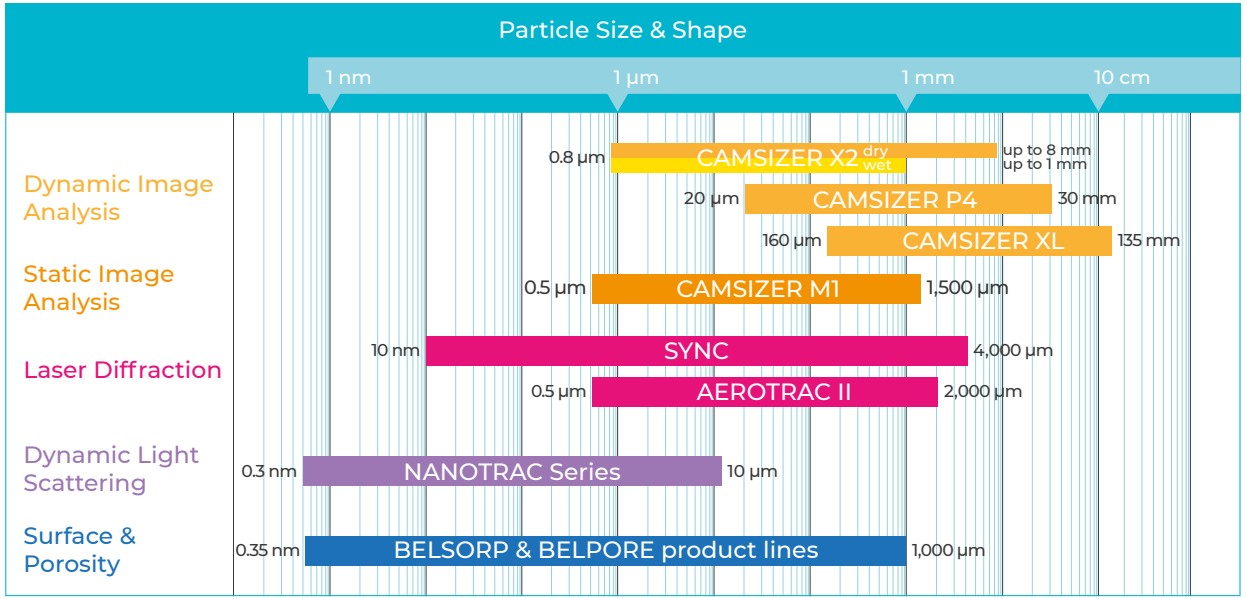
PARTICLE CHARACTERIZATION AT ITS BEST

Microtrac MRB is your preferred partner for the comprehensive characterization of particulate systems. We provide our customers with advanced technologies to obtain consistently reliable results. Innovation and quality form the basis of our business.

As part of the Verder Scientific Group we provide worldwide support through a network of subsidiaries and distributors in every country.

MICROTRAC MRB

THREE PILLARS OF EXCELLENCE



Microtrac MRB offers three product lines with centers of excellence on three continents.

I Scattered Light Analysis:

Microtrac MRB is a leading supplier of both dynamic and static light scattering systems for particle size determination. The portfolio includes laser diffraction as well as dynamic light scattering instruments perfectly suited for the characterization of nano particles. The development and production site for this product line is located in Pennsylvania, USA.

I Image Analysis:

With the CAMSIZER series Microtrac MRB provides high-quality systems for the determination of particle size and particle shape based on both static and dynamic imaging. These instruments are developed and built in our production site in Haan, Germany.

I Surface & Porosity

Specific surface, BET value and porosity of powders are determined by gas adsorption. The competence center for this product line is located in Osaka, Japan.

PARTICLE ANALYSIS DOWN TO NANOMETERS

DYNAMIC LIGHT SCATTERING BY MICROTRAC MRB

Microtrac MRB's NANOTRAC product family consists of highly flexible Dynamic Light Scattering (DLS) analyzers that provide information on particle size, zeta potential, concentration and molecular weight. Microtrac MRB is a pioneer of particle size analysis and has been developing DLS systems for over 30 years. The innovative design of the NANOTRAC series allows faster measurements with reliable technology, higher precision, and better accuracy. All of this combined into compact DLS analyzers with a revolutionary fixed optical probe.

The unique and flexible probe design allows the user to choose from a wide array of measurement cells to satisfy the needs of any application. This design also allows for measurement of samples over a wide concentration range, monomodal or multimodal samples, all without prior knowledge of the particle size distribution.

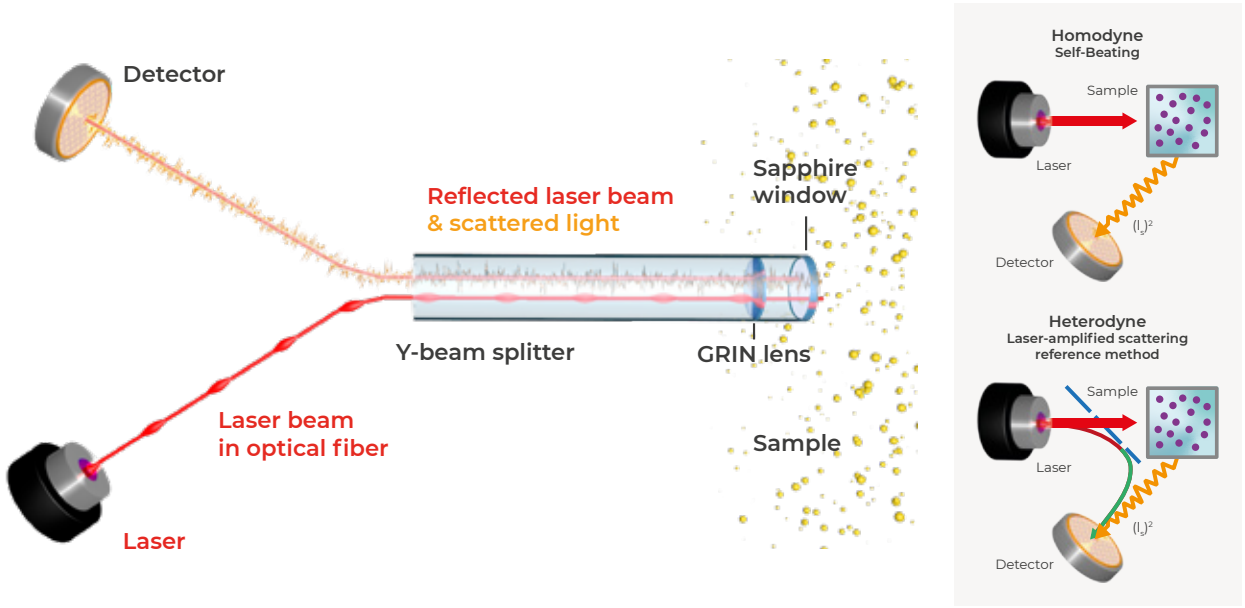
Advantages of Microtrac MRB's

DYNAMIC LIGHT SCATTERING

- Measurement range from 0.3 nm to 10 µm
- Concentration up to 40% w/v
- Minimum volume of 5 µl
- Results in as little as 30 seconds
- *A priori* knowledge of the sample not required
- Easy detection of multimodal and broad distributions without any need to select or input additional information
- Repeatability better than 1% for 100 nm polystyrene
- Temperature range from 4°C to 90°C
- 180° backscatter DLS setup
- Fixed optical setup including external measurement probe
- Frequency Power Spectrum calculation model instead of PCS
- Controlled reference optical signal
- Concentration measurement
- ISO 13099-2:2012 and 22412:2017
- FDA 21 CFR Part 11 compliant

NANOTRAC SERIES

180° DYNAMIC LIGHT SCATTERING, THE MICROTRAC WAY



Nanoparticles suspended in a liquid dispersion are subject to Brownian motion, which is a result of random collisions from molecules in the liquid medium. The particles' velocity distribution, averaged over time, approaches a known functional form – their size distribution. Dynamic Light Scattering (DLS) is the technology used to calculate that size distribution, based on the particles' measured velocity distribution.

The optical bench of the NANOTRAC line is a probe containing an optical fiber coupler with a Y splitter. Laser light is focused on a volume of sample at the interface of the probe window and the dispersion. The high reflectivity sapphire window reflects a portion of the laser beam back to a photodiode detector. The laser light also penetrates the dispersion and the particle's scattered light reflects at 180 degrees back to the same detector. The scattered light from the sample has a low optical signal relative to the reflected laser beam. The reflected laser beam mixes with the scattered light from the sample, adding the high amplitude of the laser beam to the low amplitude of the raw scatter signal. This Laser Amplified Detection method provides up to 10^6 of times the signal to noise ratio of other DLS methods like Photon Correlation Spectroscopy (PCS) and NanoTracking (NT).

A Fast Fourier Transform (FFT) of the Laser Amplified Detection signal results in a linear frequency power spectrum which is then transformed into logarithmic space and deconvoluted to give the resulting particle size distribution. Combined with Laser Amplified Detection, this frequency power spectrum

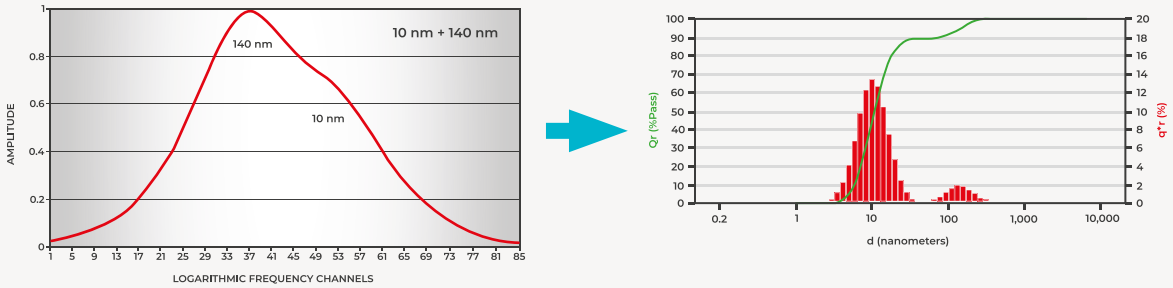
Features

- Complete optical bench in a compact fiber probe
- Laser Amplified Detection technology
- Highest signal-to-noise ratio in the industry
- One calculation for all sample types independent of concentration or distribution shape
- One measurement at one angle, 180°
- Measures particle size, zeta potential, molecular weight, and concentration

calculation provides robust calculation of all types of particle size distributions – narrow, broad, mono- or multi-modal – with no need for *a priori* information for algorithm fitting as it is for PCS.

Our Laser Amplified Detection method is unaffected by signal aberrations due to contaminants in the sample. Classical PCS instruments need to either filter the sample or create complicated measurement methods to eliminate these signal aberrations.

Iterative Particle Size Calculation from Power Spectrum



1. Estimate size distribution
2. Calculate estimated particle size
3. Calculate error in particle size
4. Correct estimated distribution
5. Repeat 1-4 until error is minimized
6. Minimum error distribution is best fit

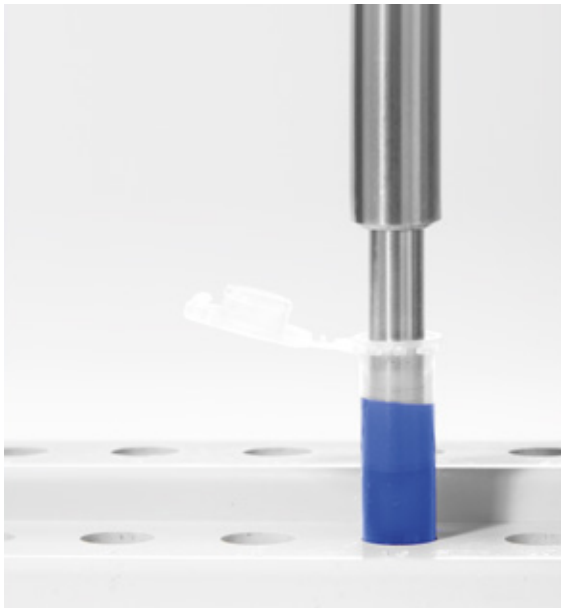
NANOTRAC FLEX

FLEXIBLE *IN SITU* MEASUREMENTS

- Most flexible DLS ever
- Unique external probe design
- *In situ* particle sizing and monitoring
- Turn any vessel into a sample cell
  – no consumables required
- External probe allows dip and measure
- Universal solvent compatibility
- Small footprint

The unique probe design of the NANOTRAC FLEX allows the measurement of only one droplet as shown in the top left figure. In this case only a minimum sample volume is needed. The probe also fits easily into a 1.5 mL Eppendorf Tube® (top right figure). With the NANOTRAC FLEX, every vessel can be used as a measurement vessel, and there is no need for cuvettes of any kind. This allows the use of the probe either at line or in line to monitor the particles growing during a reaction. During a reaction, the dispersion is either flowing or stirring. The dispersion motion will obscure the Brownian motion, and a DLS measurement is normally not possible. To measure in stirring or moving liquids, the FlowGuard (right bottom figure) can be used. The FlowGuard creates an enclosure around the probe, which shields the measurement surface from turbulent flow. An orifice ensures the constant exchange of the sample, while slowing down the stirring movement at the probe interface. This design ensures an accurate particle size distribution that is representative of the suspension outside the enclosure. The NANOTRAC FLEX probe is also very easy and quick to clean between sample measurements of any kind.

Measurement of a droplet on the tip of the probe



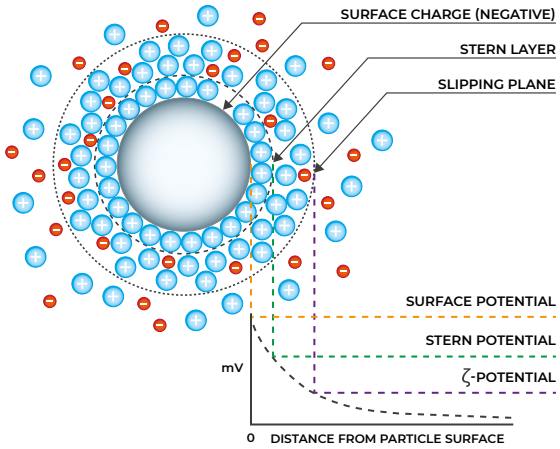
Dip-in measurement with an Eppendorf tube®

Measurement in a beaker or any other vessel

Measurement with the FlowGuard in a vessel

NANOTRAC WAVE II

IDEAL FOR NANOPARTICLE & ZETA POTENTIAL ANALYSIS



Features

- Stable fixed optics sample interface – no adjustments required
- Rapid field reversal prevents electro-osmosis
- Robust mobility calculation as a function of power spectrum ratio
- High concentration zeta potential measurements
- Sample concentration and molecular weight determination
- Laser Amplified Detection – high signal to noise ratio

The measurement of zeta potential in the Microtrac MRB DLS analyzers takes advantage of the same Power Spectrum methodology used for measuring nanoparticle size distributions. The same stable optics sample interface means no adjustments are required. The backscatter and laser amplified detection signals are collected as in the size measurement, and the rapid sequencing of applied electric fields prevents electroosmosis. The optical probe interface surface is coated to provide electrical contact with the sample. Two probes are used, one to determine the polarity of the particle charge at the slipping plane and one to measure the mobility of the particles in an electric field. Polarity is measured in a pulsed electric field, while mobility is measured in a high frequency sine wave electric field excitation. The Zeta cell has two detection probes, on opposite sides, to detect polarity and mobility.

From the linear frequency power spectrum distribution (PSD), the Loading Index (LI), which is proportional to particle concentration, can be calculated. Loading Index values provide a

NANOTRAC WAVE II Q

ACCURATE MEASUREMENT OF COLLOIDAL SYSTEMS

single number for total scattering that can be used to determine particle mobility in microns / sec / volt / cm and particle polarity as + / -, positive or negative.

Measuring mobility and zeta potential begins by measuring the PSD and determining the LI with the excitation off. Then the PSD is measured with the high frequency sine wave on and a ratio is taken. Polarity is determined by measuring the LI before and after pulsed DC excitation. A ratio of LI after the excitation divided by LI before excitation of less than one is a positive polarity (concentration decreasing) and a ratio greater than one is negative (concentration increasing) for a positively charged probe surface.

Mobility = C x (ratio of [PSD(on) – PSD(off)] / LI(off)

Zeta Potential ∝ Mobility

Microtrac MRB's NANOTRAC series can also calculate the sample concentration by measuring the power spectrum and the loading index. Depending on the distribution calculation, concentration will be displayed in appropriate units such as cm^3/ml or N/ml (as seen below). It is also possible to calculate the molecular weight by either the hydrodynamic radius or a Debye plot.

Mode Summary (INT)				
d(nm)	Pct	Width	C(I)	C(V):cc/ml
9,87	88,97	5,36E+00	9,7E-02	1,07E-02
139,3	11,03	6,06E+01	1,2E-02	6,79E-07

Mode Summary (NUM)				
d(nm)	Pct	Width	C(I)	C(N):N/ml
9,87	100,00	5,36E+00	9,7E-02	2,11E+16
139,3	0,0000C	6,06E+01	1,2E-02	4,8E+08

STABINO ZETA

FAST ZETA POTENTIAL MEASUREMENT & TITRATION

- Zeta and streaming potential in one measurement
- Up to 5 measurement points simultaneously
- Charge analysis of particles from 0.3 nm up to 300 µm
- High concentration range from 0.01 to 40 vol%
- Zeta potential at high conductivity
- No optical parameter needed
- “Mix & Measure” technique
- Zeta potential mapping tool for formulation
- Can be combined with NANOTRAC FLEX for particle size analyses
- Easy to use software
- Integrated titrator by default

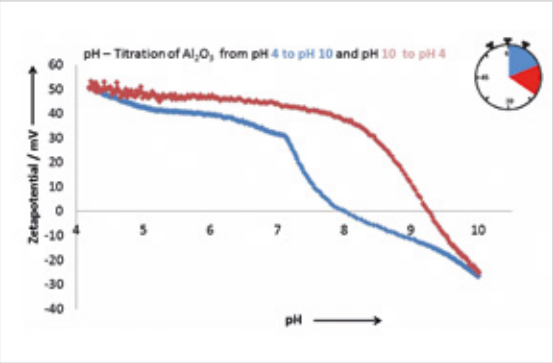
The STABINO ZETA provides very fast, precise, and reproducible zeta potential measurements due to its high resolution and data point density, respectively. The STABINO ZETA can measure the zeta potential of particles in a range of 0.3 nm to 300 µm, with a concentration range of up to 40% by volume.

Thanks to the unique measurement technology, the STABINO ZETA can determine five parameters simultaneously within a few seconds. **In combination with Microtrac MRB's DLS analyzer, NANOTRAC FLEX, the size can be measured at the same time, in the same sample.**

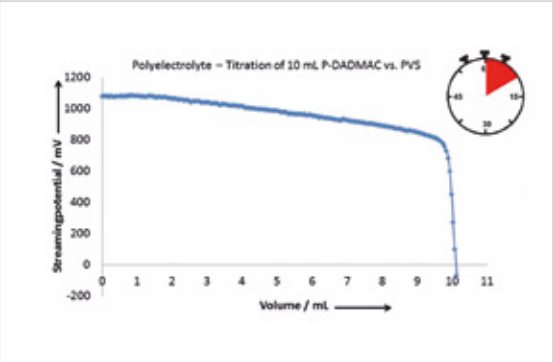
In addition, the STABINO ZETA has a built-in titration function where all the parameters are analyzed simultaneously at every dosage step. The determination of the isoelectric point is one of the possibilities of titration and is completed within a few minutes.

The titration applications are:

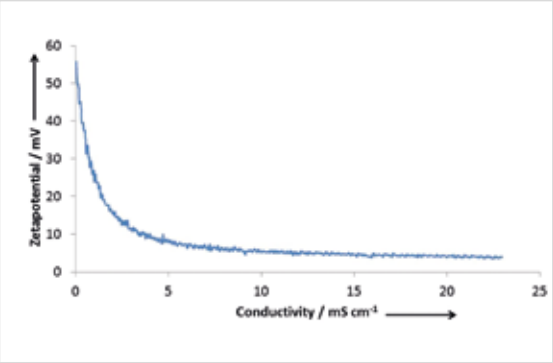
- pH titration
- Polyelectrolyte titration
- Titration with salts



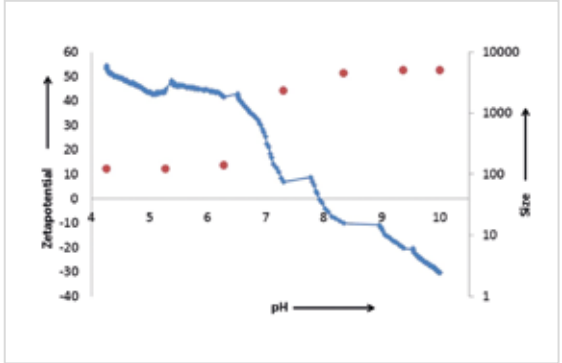
pH forth and back titration of Al_2O_3 from pH 4 to 10 and from pH 10 to 4 with a hysteresis effect



Polyelectrolyte titration of 10 mL P-DADMAC against PVS shown here in streaming potential



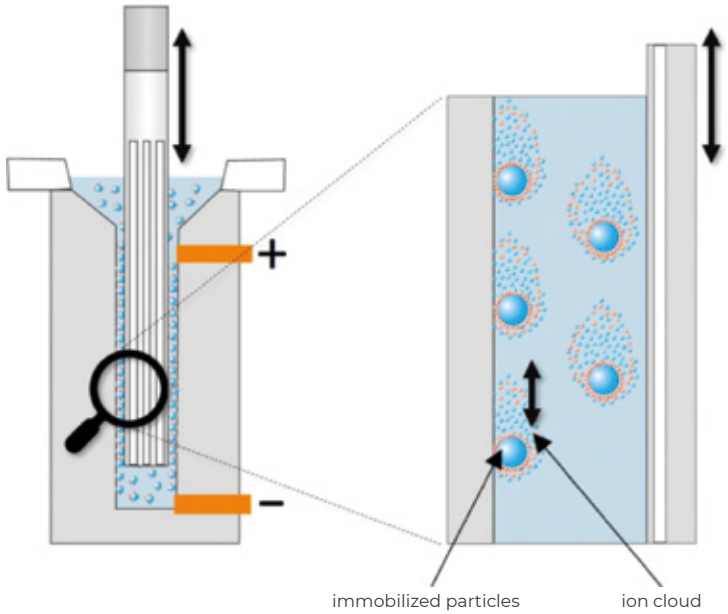
Salt titration of Al_2O_3 with 1 mol/l KCl to see the influence of the change of conductivity on zeta potential



pH Titration of Al_2O_3 from pH 4 to 10. The size was measured with the DLS analyzer NANOTRAC FLEX to determinate the conglomeration point

STABINO ZETA

ZETA POTENTIAL AND TITRATION FOR COMPLETE STABILITY



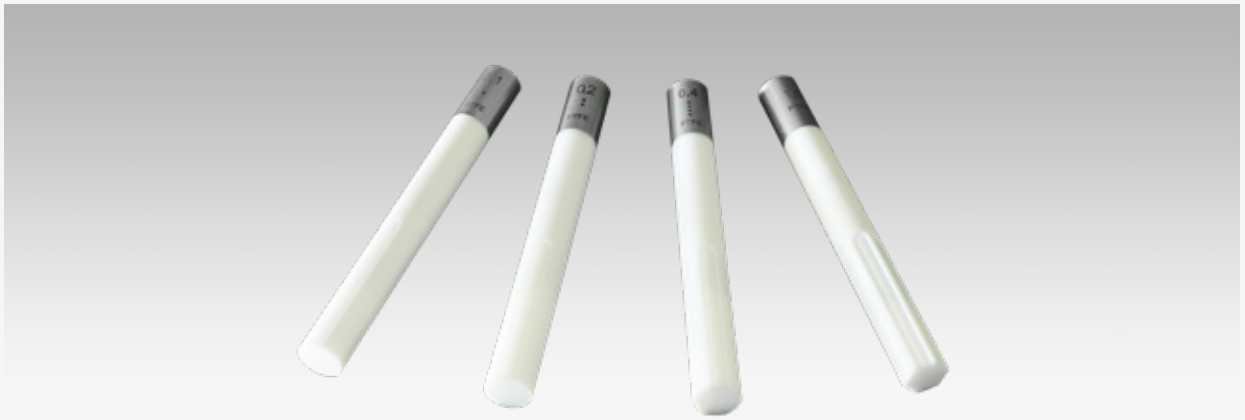
Features

- 5 measurement parameters at the same time
- “Mix and Measure” – an enourmous advantage
- Adjusted titration speed
- Fast measurement time
- Extension: In-situ size distribution
- Simple operation

The core of the Stabino ZETA is a cylindrical PTFE measuring cup with an oscillating piston. Charged particles generate an ion shell in polar liquids to balance the charge between the particle surface and the liquid. This ion cloud can be deformed by a movement of the solvent, resulting in charge separation. The STABINO ZETA generates this charge separation by a liquid flow due to the oscillating motion of the plunger. The particles are immobilized on the walls of the beaker and the liquid flow causes the charge separation. The level of charge separation (the zeta or streaming potential) is measured via two electrodes and is an indicator of the stability of the particles against agglomeration. After appropriate calibration, the measuring signal is output as flow potential or zeta potential. The titration solutions are added via integrated pumps consisting of two storage containers. The liquid movement leads to rapid homogenization during titration and allows rapid measurements. In addition to zeta potential and titrant volume, from which the particle charge density is calculated, temperature, pH value and conductivity are also measured.

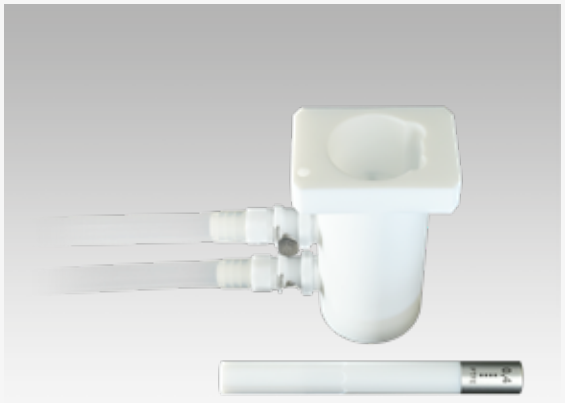
ADDITIONAL SOLUTIONS

ACCESSORIES & TECHNICAL SPECIFICATIONS



PISTON SET (100, 200, 400 and 1000 µm)

MEASURING CELL (1 and 3 ml, including piston)



TEMPERED MEASURING CELL (0°C to 90°C)

MEASURING CELL (black, 10 ml)

MICROTRAC MRB

APPLICATIONS

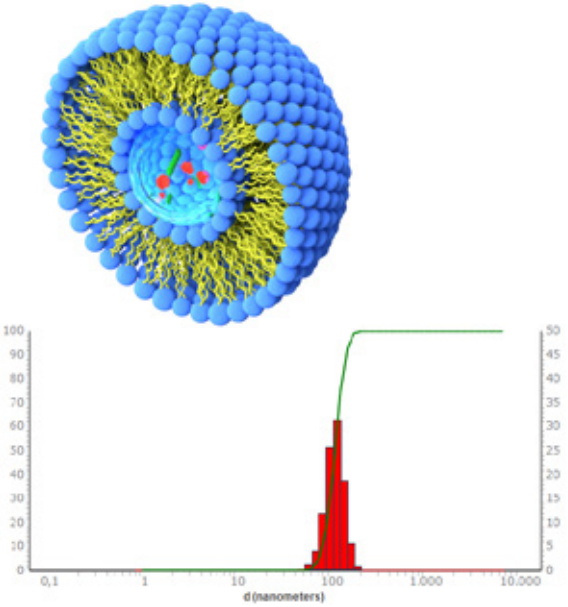
Versatility is a great strength of dynamic light scattering (DLS) analysis. This makes the method suitable for a variety of applications in both research and industry. Microtrac MRB's NANOTRAC series was designed for convenient, easy-to-learn operation. Thanks to their robust design, the instruments are practically maintenancefree and fit for 24/7 operation. The high sample throughput and the extremely wide particle size range from 0.3 nm to 10 µm are reasons for the method's popularity in so many laboratories.

TYPICAL FIELDS OF APPLICATION

- PHARMACEUTICALS
- INKS / PIGMENTS
- LIFE SCIENCES
- CERAMICS
- BEVERAGES & FOOD
- COLLOIDS
- POLYMERS
- MICROEMULSIONS
- COSMETICS
- CHEMICALS
- ENVIRONMENTAL
- GLUES
- METALS
- INDUSTRIAL MINERALS

PARTICLE SIZE OF CAPSULES FOR DRUG DELIVERY SYSTEMS (DDS) – A CARRIER FOR ANTI-CANCER AGENTS

Drug Delivery Systems (DDS) allow drugs to be delivered efficiently to the affected site while suppressing their adverse effects for the rest of the human body. If the size of the particles constituting the DDS is controlled, it is possible to allow the needed amount of a given drug to be absorbed via a specific site in a living body. Often liposomes will be used as Drug Delivery Systems. Liposomes can be phospholipid capsules possessing an isolated inner aqueous layer in a double-structure lipid membrane, identical to the membranes found in a living body. They are highly effective in suppressing adverse effects and are thus able to be developed, among others, as a carrier for anti-cancer agents. Also, in the field of cosmetics, this kind of capsule has recently begun to be used in various products as it enables the functional ingredients of cosmetics to penetrate efficiently into the keratinous skin layer.

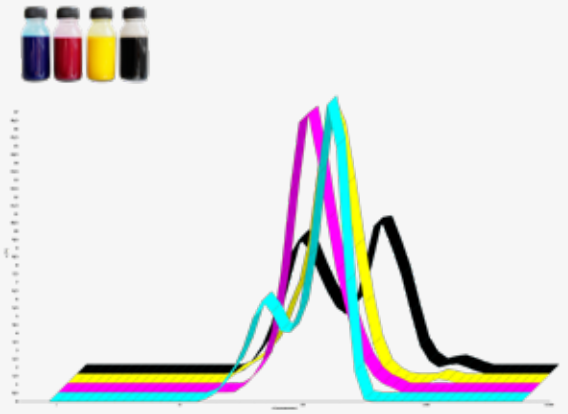


PARTICLE SIZE OF INKS – IN ORIGINAL CONCENTRATION WITHOUT DILUTION

Modern printing inks contain many components, each having a specific purpose in maintaining color, intensity, dispersion, viscosity, as well as acting as a milling aid. The resulting light scattering affects light fastness, shade, and intensity of color.

The figure shows a typical printout for different colored inks. Note the presence of the bimodal distribution. The samples were measured using the original concentration. The second mode may be indicative of agglomerated particles or individual coarse particles. It may also be characteristic of the ink.

The NANOTRAC DLS analyzer family has the capability to measure inks of all colors including black, magenta, yellow and cyan. The measurement can be conducted using high concentrations and can reveal special distribution features such as bimodal distributions and changes in particle size.



Particle size distribution of non-diluted inks (intensity distribution)

ADDITIONAL SOLUTIONS

ACCESSORIES & TECHNICAL SPECIFICATIONS

NANOTRAC FLOWGUARD

- The NANOTRAC FLOWGUARD facilitates in situ DLS measurements in a process environment, such as reaction vessels or pipes.

NANOTRAC WAVE II SAMPLE CELLS

- The NANOTRAC WAVE II can be used with a variety of removable, re-usable sample cells that are available in Teflon or stainless steel at varying volumes (50 µl - 3.5 ml).

NANOTRAC ZETA SAMPLE CELL

- The fully removable and re-usable zeta potential sample cell can be easily accessed for thorough cleaning and re-inserted in the instrument, providing real cost savings.

NANOTRAC WAVE II Q CUVETTES

- The NANOTRAC WAVE II Q is available with a variety of sample cuvettes in glass or plastic at varying volumes, and stainless steel for industrial samples like inks.

ZETRATOR

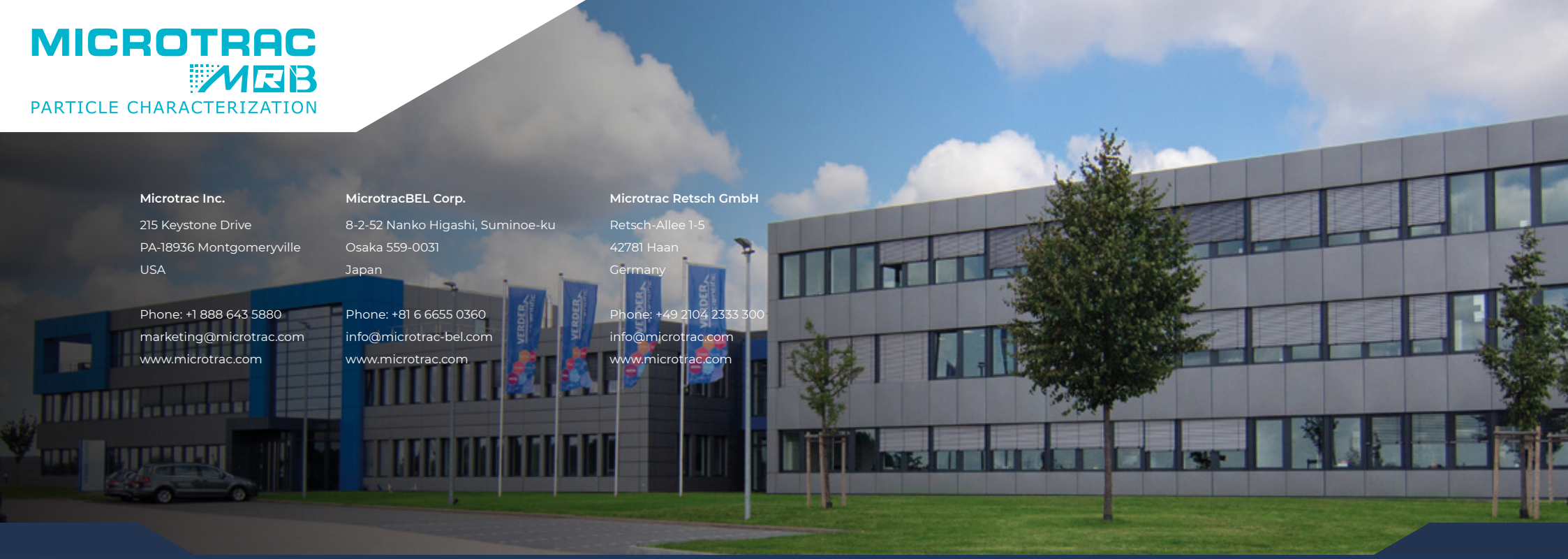
- The ZETRATOR can be used for titrating acids, bases, and salts. It covers a pH range from 2 up to 12 and can have 1, 3 or 5 different titrants. The minimum dosage is 20 µl.

System	NANOTRAC WAVE II	NANOTRAC WAVE II Q	NANOTRAC FLEX	STABINO ZETA
Method	Backscattered laser-amplified scattering reference method			Zeta streaming potential
Calculation model	FFT power spectrum			-
Measurement angle	180°			-
Measurement size range	0.3 nm – 10 µm			✓
Zeta potential measurement	✓	-		
Zeta measurement range (potential)	-200 mV – +200 mV	-		-3000 mV – +3000 mV
Zeta measurement range (size)	10 nm – 20 µm	-		0.3 nm – 300 µm
Electrophoretic mobility	0 – 15 (µm/s) / (V/cm)	-		max. 200 (µm/s) / (V/cm)
Conductivity measurement	✓	-		✓
Conductivity range	0 – 10 mS / cm	-		up to 350 mS / cm
Molecular weight measurement	✓			-
Molecular weight range	< 300 Da -> 20 x 10^6 Da			-
Temperature range	+4°C – +90°C			0°C – +90°C *
Temperature accuracy	± 0.1°C			
Temperature control	✓		-	✓
Temperature control range	+4°C – +90°C	+4°C – +70°C (PE cuvette) +4°C – +90°C (glass cuvette)	+4°C – +90°C	0°C – +90°C
Titration	✓	-		✓
Titration type	pH	-		pH, polyelectrolyte, salt
Titration endpoints	pH, volume	-		pH, zeta potential, conductivity, volume and time
At line / in line measurement	-		✓	-
Reproducibility (size)	≤ 1			
Reproducibility (zeta)	± 3%	-		± 3%
Sample volume size measurement	50 µl – 2 ml	50 µl – 3 ml	2 µl – ∞	-
Sample volume zeta measurement	150 µl – 2 ml	-		950 µl – 10 ml
Concentration measurement	✓			-
Sample concentration	up to 40 % (sample dependent)			
Carrier fluids	water, polar and unpolar organic solvents, acid and base (cuvette-depending with NANOTRAC WAVE II Q)			
Laser	780 nm, 3 mW; 2 laser diodes with zeta			-
Humidity	90 % non-condensing			

*No need for dry gas purge

MICROTRAC MRB

PARTICLE CHARACTERIZATION



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VERDER scientific

VERDER SCIENTIFIC

SCIENCE FOR SOLIDS

Verder Scientific is a business field belonging to the Verder Group and sets standards in the development, manufacture and sale of laboratory and analytics devices. Used in quality control, research and development for test-piece preparation and the analysis of solids.

For several decades our companies have supplied production plants and research institutes, laboratories for quality testing and analytics, all kinds of technical specialists and scientists with modern, reliable devices to solve the many and varied challenges they face.

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