

Bettersizer S3 Series

- Precise analysis of small particles as from 10 nm
- Realistic measurement up to 3.5 mm
- Combined size and shape analysis
- Concentration-based determination of the refractive index
- Perfect price-performance ratio



Particle size and -shape
by means of laser diffraction
and dynamic image analysis

Bettersizer S3 Series Overview

The Bettersizer S3 series – particle size and shape in one instrument

The Bettersizer S3 series combines the advantages of both static light scattering and dynamic image analysis by using a unique and innovative setup. The instrument offers a thorough and exact characterization with regards to particle size and shape ranging from nanometer up to millimeter scale.

The live view through the CCD cameras before and during a measurement allows an evaluation of the dispersion state of the sample and a visual assessment of the obtained measurement result. All particles with sizes above 2 µm can be photographed and analyzed online.

Key Benefits

- **Innovative dual lens technology (DLOIOS)**
 - Exact measurement of small particles as from 10 nm
 - Single laser technology for continuous scattering spectrum
- **Integrated camera technology**
 - Higher accuracy in the coarse range compared to laser diffraction only
 - Detection of individual large grains, agglomerates or air bubbles
- **Particle size and shape analysis in one instrument**
 - Realistic measurement of irregularly shaped particles
- **Concentration-based determination of the refractive index**
 - Precise measurement of unknown samples

Comparison of Bettersizer S3 and Bettersizer S3 Plus

Model	Bettersizer S3	Bettersizer S3 Plus
Measuring range laser diffraction	0.01-3,500 µm (sample dependent)	0.01-3,500 µm (sample dependent)
Measuring range image analysis	100-3,500 µm (sample dependent)	2 - 3,500 µm (sample dependent)
Measuring method	- Laser Diffraction: DLOIOS - Dynamic image analysis: one CCD camera with 0.5X lens	- Laser diffraction: DLOIOS - Dynamic image analysis: two CCD cameras with 0.5X and 10X lens



Figure 1 Precise measurement: The Bettersizer S3 Plus successfully passed the round robin test RV BAM-5.5-2019 of the German Federal Institute for Materials Research and Testing (BAM) with a result of 100 %.

Bettersizer S3 Series Measurement principle

The Bettersizer S3 Plus at a glance

The Bettersizer S3 Plus is a static light scattering device that is additionally equipped with two high-speed CCD cameras (0.5X and 10X lens) for capturing images of the sample.

During the measurement, the particles (dispersed in the solvent of choice) are pumped through two measuring cuvettes. In the first cuvette, short-wavelength laser light (532 nm) hits the particles and generates a characteristic diffraction pattern. This pattern is measured by the detector system as a function of the diffraction angle. In the second cuvette, the CCD cameras are constantly recording particle images in the range from 2 to 3,500 μm .

Patented dual lens technology (DLOIOS)

DLOIOS (Dual Lenses & Oblique Incidence Optical System) is a new fourier-based technique patented by Bettersize. An additional lens between the cuvette and the laser changes the divergent beam into a parallel beam, allowing also for the detection of backscattered light.

The use of only one laser results in a continuous diffraction spectrum with consistent wavelength, while the oblique incidence of the beam combined with this special setup enables a detection in the angular range of 0.02 – 165°. The DLOIOS technology guarantees a reliable measurement of particles as small as 10 nm.

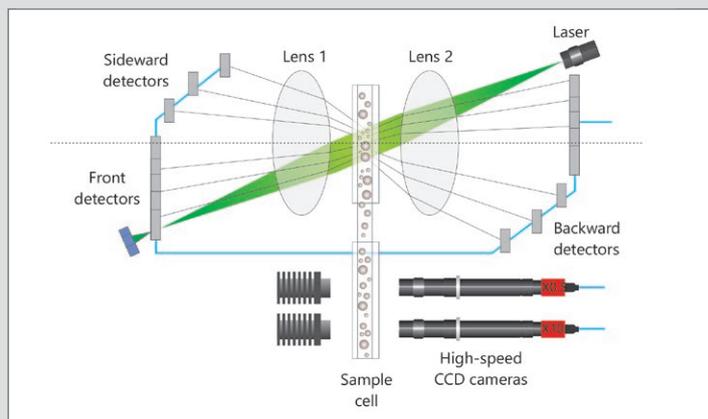


Figure 2 Schematic setup of a Bettersizer S3 Plus

CCD camera technology

The optical imaging system consists of two high-speed CCD cameras and high-precision telecentric lenses. This allows for the recording and analysis of more than 10,000 particles per minute with a sharp focus and without shadowing effects. Both cameras can be used individually or simultaneously for sample observation or for online image analysis.

DLOIOS (Dual Lenses & Oblique Incidence Optical System)

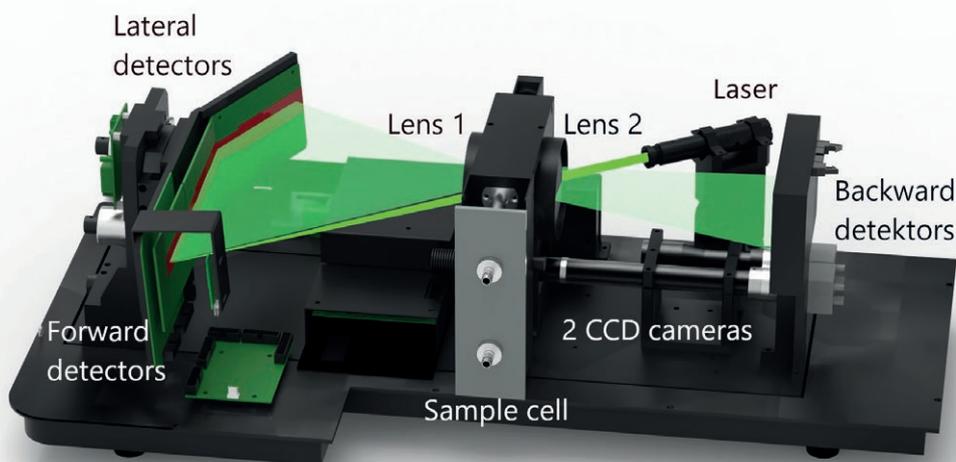


Figure 3 Illustration of the optical bench and the DLOIOS (Dual Lenses & Oblique Incidence Optical System)

Betttersizer S3 Series Particle size and shape measurement

Particle size measurement

Static light scattering according to DIN ISO 13320

The size distribution of fine particle collectives (nano-, submicro- and micrometer region) can be determined precisely by means of the DLOIOS technique. A wide measurement range for the scattered light ($0.02\text{--}165^\circ$) is accessible in conjunction with a high detector resolution (96 channels). This enables the characterization by means of laser diffraction according to DIN ISO 13320 over the entire measurement range of $0.01\text{--}3,500\ \mu\text{m}$. Analysis can be carried out according to Fraunhofer or Mie theory. Additional helpful tools for particle size analysis are the two cameras as a visual verification of the dispersion quality as well as the measurement of the complex refractive index for materials with unknown optical parameters.

Combined method: Image analysis with light scattering

For particle collectives with a broad distribution and fractions in the upper micro- to millimeter range, a combined analysis of static light scattering and dynamic image analysis using a CCD camera with a 0.5X lens for accurate detection of coarse particles is advised. This allows for the detection of less than 3 mass-% oversize material.

Determination of particle shape and equivalent diameter

Particle shape analysis

Shape analysis can be carried out with two high-speed CCD cameras with 0.5X and 10X lens, respectively. They cover a range of $2\text{--}3,500\ \mu\text{m}$ for particle size measurement by dynamic image analysis; particle shape analysis is possible at $4\ \mu\text{m}$ and above. The analysis is carried out in real time at a rate of 10,000 particles per minute, which are photographed, characterized and classified statistically. Both cameras can be used independently or simultaneously.

Apart from a variety of equivalent diameters such as area, circumference, maximum and minimum Feret, a number of special size parameters such as aspect ratio, circularity and perimeter can be calculated.

Thanks to the intuitive software, these characteristics can be displayed as single particle features as so-called trend graphs (shape vs. size, Figure 6) and as distribution functions of the particle of the particle collective (Figure 7).

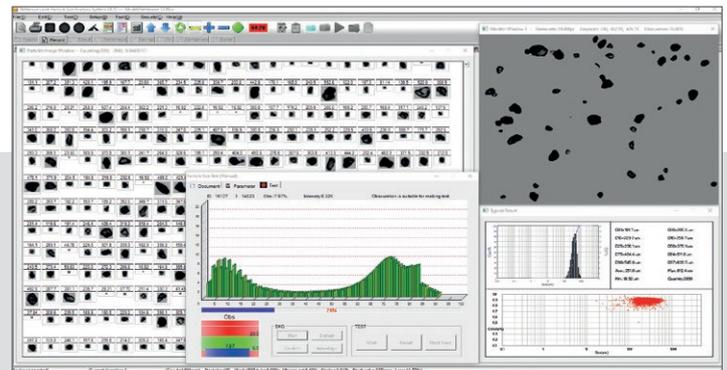


Figure 4 Real-time signals and images of the CCD cameras

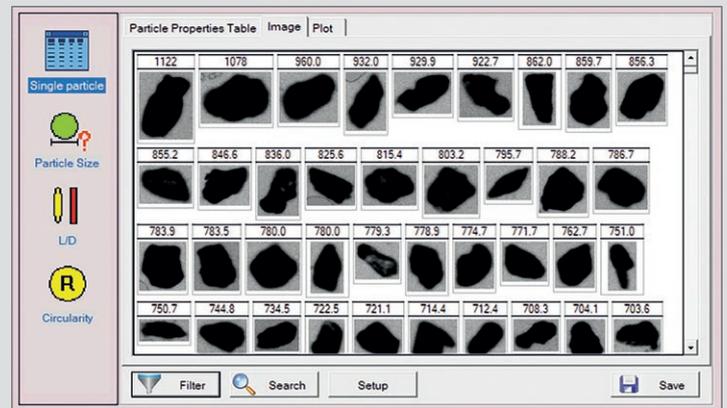


Figure 5 Extract of the single particle list in the software

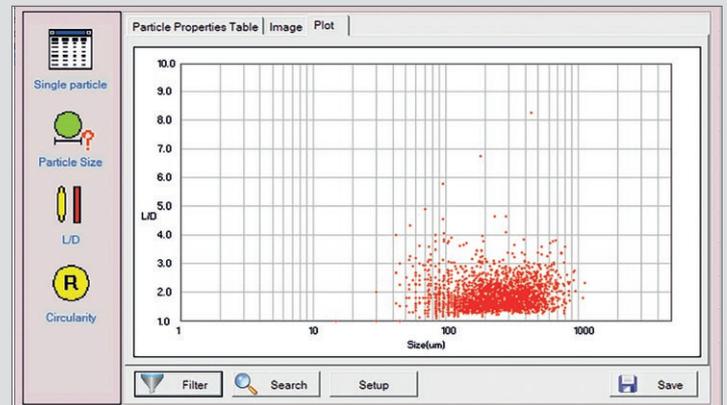


Figure 6 Trend graph (shape vs. size) for visualization of single particle features and detection of "conspicuous" particles

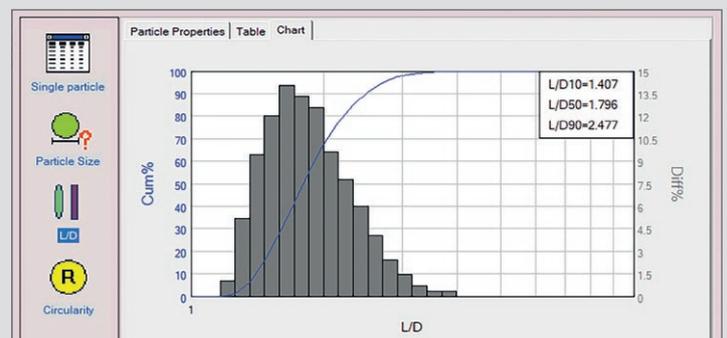


Figure 7 Sum distribution function and histogram for the description of the shape distribution of the particle collective

Advanced User Level Concept - Compliant with FDA 21 CFR Part 11

The rights of the users can be configured on the basis of a selection of defaults (Senior, Intermediate, Common) and can also be changed individually. This prevents unauthorized data manipulation and ensures compliance with 21 CFR Part 11.

Login Name	User	Remarks
Admin	Admin	
Guest	Guest	
User 1	User 1	
User 2	User 2	
User 3	User 3	

Group	Remarks
Advanced	
Intermediate	
Beginner	
Viewer	

Figure 8 Overview of the different users and user groups

Group Name: <input type="text" value="Advanced"/>	<input checked="" type="checkbox"/> OK						
Remarks: <input type="text"/>	<input checked="" type="checkbox"/> Cancel						
List:	<input type="button" value="Add"/>						
<table border="1"> <thead> <tr> <th>Login Name</th> <th>Remarks</th> </tr> </thead> <tbody> <tr> <td>User 1</td> <td></td> </tr> <tr> <td>User 3</td> <td></td> </tr> </tbody> </table>	Login Name	Remarks	User 1		User 3		<input type="button" value="Delete"/>
Login Name	Remarks						
User 1							
User 3							
Authority:	<input type="button" value="Senior"/>						
<input checked="" type="checkbox"/> SOP Database	<input type="button" value="Intermediate"/>						
<input checked="" type="checkbox"/> PMT Database	<input type="button" value="Common"/>						
<input checked="" type="checkbox"/> RI	<input type="button" value="Tick"/>						
<input checked="" type="checkbox"/> Particle Size Test (Manual)	<input type="button" value="Untick"/>						
<input checked="" type="checkbox"/> Particle Size Test (SOP)							
<input checked="" type="checkbox"/> Particle Size Test (Auto-Sampler)							
<input checked="" type="checkbox"/> Refractive Index Measurement							
<input checked="" type="checkbox"/> Performance Qualification							
<input checked="" type="checkbox"/> Print the result							
<input checked="" type="checkbox"/> Export the result							
<input checked="" type="checkbox"/> Particle Size Classification							

Figure 9 Assignment of rights to individual users

Use of Standard Operational Procedures (SOP)

Using an SOP saves time and standardizes test conditions, minimizes errors caused by different users, and improves the reproducibility of test results.

Before using an SOP, the measurement conditions such as the duration of ultrasonic dispersion, the stirring speed, the background measurement and the storage of the results can be specified.

Figure 10 Dropdown selection of the correct SOP before measurement

Figure 11 Menu for setting the measurement conditions such as optical and test parameters

Figure 12 Menu for defining the dispersion settings

Bettersizer S3 Series Accessories



Autosampler BT-A60

The autosampler doses fully automatically up to 60 samples no matter if they are dry powders or pre-dispersed liquid dispersions. The included barcode printer ensures that the results are recorded for the corresponding sample. The sampler is cleaned by ultrasound to avoid contamination.

- Suitable for powders and dispersions
- Sampling volume: 0.5 – 5 ml
- Capacity sample vial: 10 ml

Video:



Additional external ultrasound

By means of this external, controllable ultrasound option, the measurement of difficult-to-disperse and reagglomerating systems is made possible.

- Additional ultrasound unit for BT-802/BT-803
- Adjustable up to 200 W
- Incl. mounting and assembly



Solvent-resistant small volume dispersing unit BT-80N

The BT-80N external small volume dispersion unit is ideally suited for reproducible particle size measurement in polar and non-polar solvents. Due to the small volume of liquid, the consumption of solvent is low. The effective and controllable ultrasonication allows the measurement of difficult to disperse and reagglomerating systems.

Cleaning and a sample or solvent change is very easy due to the quick-lock system. The sample feed to the Bettersizer S3/S3 Plus is realized via a solvent resistant tube and controlled manually.

- Sample volume: approx. 80 ml
- Stainless steel stirrer vessel with centrifugal pump and quick-lock mechanism
- Ultrasound: infinitely variable power up to 50 W
- Variable pump or stirring speed
- Display for function monitoring (stirring speed and ultrasonic strength)
- Suitable for aqueous, polar and non-polar solvents



Automatic Recycling Unit A.R.U.

With the online dispersant recycling A.R.U., you can easily and quickly reduce solvent consumption, e.g. of isopropanol.

- 2 x 20 l stainless steel pressure vessel
- Mounted on a stainless-steel frame



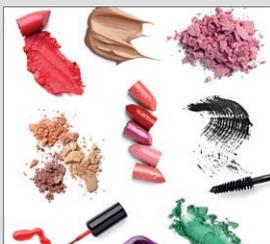
Betttersizer S3 Series Specifications & Applications

Specifications	
Measurement principle	static light scattering and dynamic image analysis
Analysis	Fraunhofer or Mie
Measurement range light scattering image analysis	0.01 - 3,500 μm (sample dependent) 2 - 3,500 μm (S3 Plus), 100 - 3,500 μm (S3) (sample dependent)
Number of size classes	> 100 / individually adaptable
Time of measurement	< 1 min
Accuracy / Repeatability / Reproducibility	< 0.5 % / < 0.5 % < 1.0 %
Feeding / Dispersion / Volume	centrifugal pump / ultrasonic bath (50 W) / 600 ml
Number of laser / -type / -wavelength / -powder / -class	1 / diode laser (DPSSL) / 532 nm (green) / 5 mW / class 1
Lenses design / -arrangement	F-Theta / double-lenses Fourier optic, oblique incident light
Effective focal length	223 mm, image analysis: 110 mm
Detector channels, -angle range	96 (forward, sideward and backward), 0.02 - 165°
Special features: additional determination of	particle shape (L/D, circularity...), refractive index
Conformity	21 CFR Part 11, ISO 13320, CE
Data export	Excel, PDF, Word, JPG and others
Dimension / weight	820 x 650 x 320 mm (L x D x H) / 30 kg
Recommended computer specification	Windows 7 or higher, Intel Core i7, 4 GB RAM, USB 2.0

Applications



Building materials



Personal care and cosmetics



Soils and sediments



Glass and ceramics



Carbon and oil



Food and beverages



Paints and inks



Pharmaceuticals



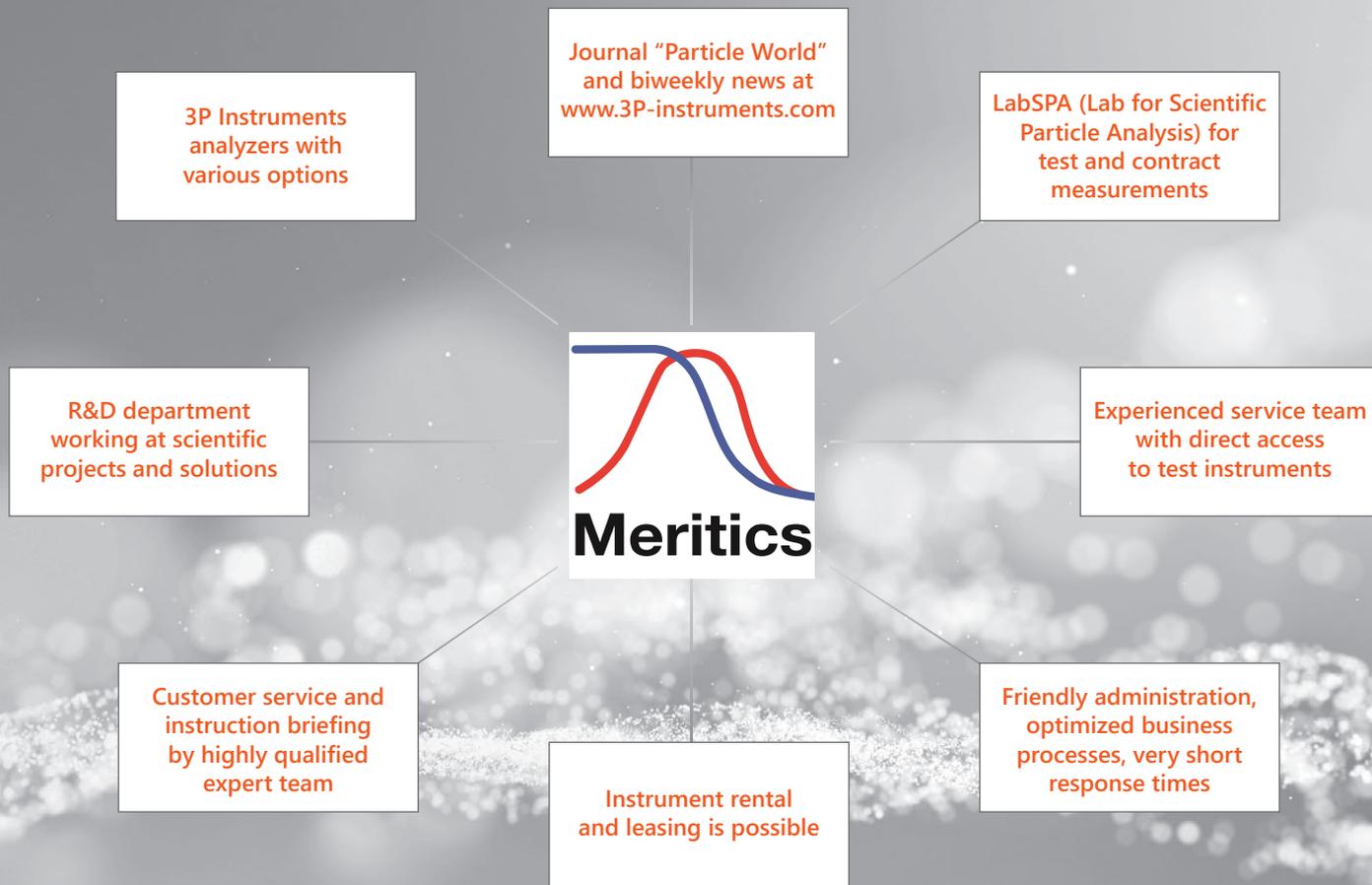
Polymers and metals



Electronics

Your partner in particle characterization

3P Instruments has over 30 years of profound expertise in the characterization of emulsions and dispersions, of particles and powders as well as surfaces and pores.



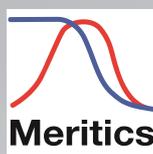
We are happy to provide further information on the other particle sizers of the Bettersizer series.



Bettersizer 2600



Bettersizer ST



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