

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	0.01-3,500 µm
Measuring range image analysis	100-3,500 µm	2 - 3,500 µm
Measuring method	<ul style="list-style-type: none">- Laser Diffraction: DLOIOS- Dynamic image analysis: one CCD camera with 0.5X lens	<ul style="list-style-type: none">- 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 $0.02 - 165^\circ$. The DLOIOS technology guarantees a reliable measurement of particles as small as 10 nm.

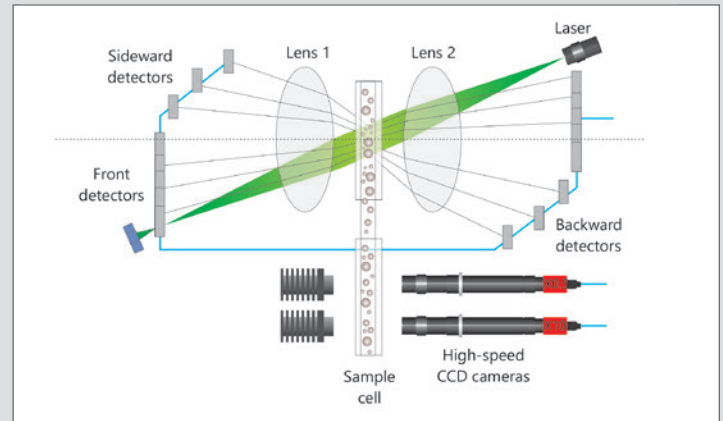


Figure 2 Schematic setup of a Bettersizer S3 Plus

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)

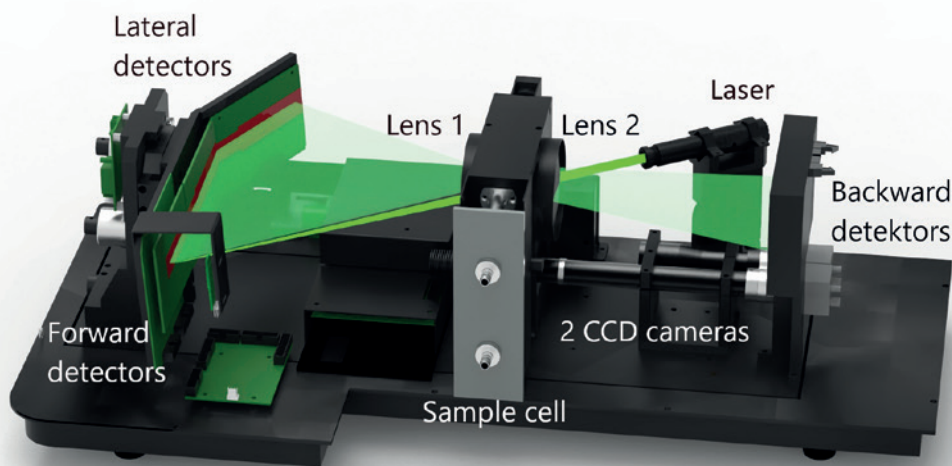


Figure 3 Illustration of the optical bench and the DLOIOS (Dual Lenses & Oblique Incidence Optical System)

Bettersizer 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 $0.01\text{--}3,500\text{ }\mu\text{m}$. 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 $2\text{--}3,500\text{ }\mu\text{m}$ for particle size measurement by dynamic image analysis; particle shape analysis is possible at $4\text{ }\mu\text{m}$ 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).

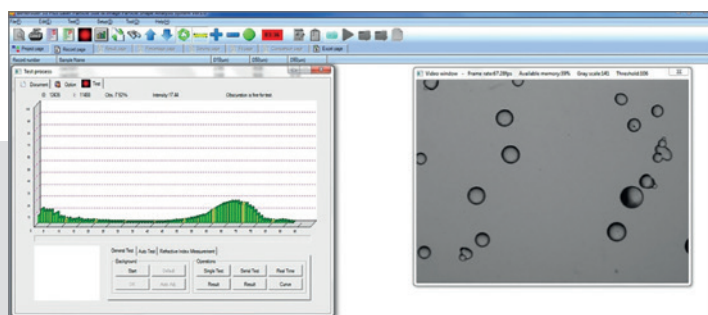


Figure 4 Real-time signals and images of the CCD cameras

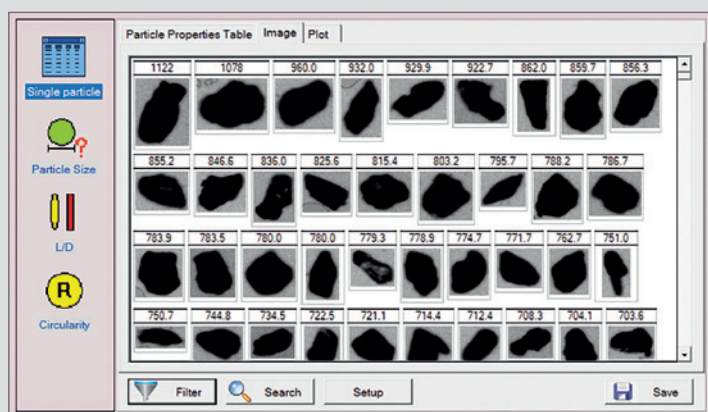


Figure 5 Extract of the single particle list in the software

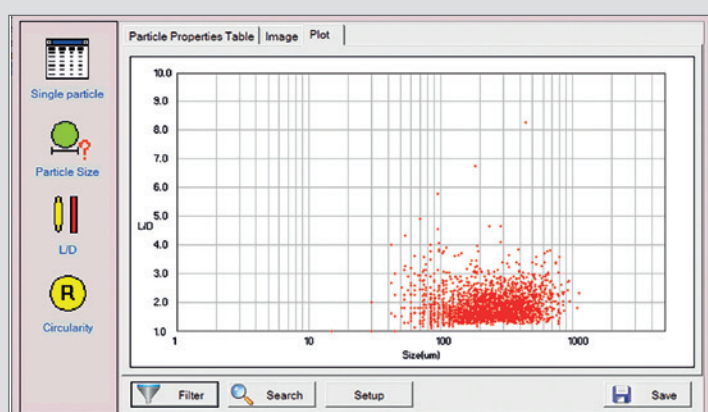


Figure 6 Trend graph (shape vs. size) for visualization of single particle features and detection of "conspicuous" particles

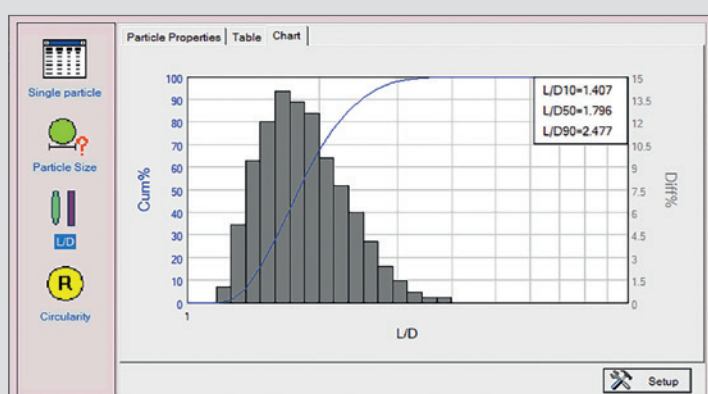


Figure 7 Sum distribution function and histogram for the description of the shape distribution of the particle collective

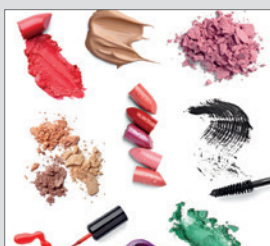
Bettersizer S3 Series Specifications & Applications

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 2 - 3,500 μm (S3 Plus), 100 - 3,500 μm (S3)
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



3P Instruments GmbH & Co. KG
Rudolf-Diesel-Str. 12
85235 Odelzhausen | Germany

Tel. +49 8134 9324 0
info@3P-instruments.com
www.3P-instruments.com